Subduing the Cumberland:
A History of the "Old" Locks and Dams on the Cumberland River

Introduction

From 1888 until 1928 the U.S. Army Corps of Engineers struggled against all odds to create a system of locks and dams along the Cumberland River to aid navigation and facilitate trade. The concept for these navigational aids began in the mid-19th century, but construction would not begin for nearly 50 years.

A perpetual shortage of money plagued this project from its inception until its completion. The Chief of Engineers was always asking for enough money to complete the project, and was always given a fraction of the sum requested, if any appropriations were forthcoming at all. But the engineers persisted and push ahead.

These locks and dams were constructed using the technology of the 19th century. Stone was quarried, cut and laid by hand. The cribs for the dams were frames built of wood, which were submerged and filled with rocks. This work was done by hand. Workers swam underwater to make repairs and feel the bottom to insure that the cribs were properly placed. Men packed down clay in the construction process with their bare feet.

Yes, there were steam dredges, trams and derricks, but these were not too far removed from the machines used by Civil War engineers. Though steam power existed, man and animal power provided the lion's share of the power that made these locks and dams a reality. Modern innovations were utilized in the process of constructing the locks and dams. Concrete was used for some of the locks and one of the dams, but for the most part the project was built the way locks and dams had been built for centuries.

Over the forty years it took to construct the fifteen locks and dams of the Cumberland Improvement Project the world changed greatly. The Annual Reports for the last few locks and dams mention connecting electricity and telephone lines to the locks and lock facilities. Automobiles and trucks were becoming commonplace, the good roads movement was underway, and this new form of transportation would soon eclipse the locomotive. Even though this system of locks and dams was almost obsolete as soon as it was completed these locks were, and are, an important part of the history of the Cumberland River, Kentucky, Tennessee and the United States.

The Cumberland River

> The Cumberland River has its source in eastern Kentucky, on the western slope of the Cumberland Mountains, which are part of the Appalachian system, " . . . flowing westwardly in a tortuous course through or washing the counties of Harlan, Bell, Knox, Whitley, Russell, Pulaski, Wayne, Cumberland and Monroe in Kentucky, and thence through Clay, Jackson, Wilson, Smith, Trousdale, Davidson, Sumner, Cheatham, Montgomery and Stewart counties, in Tennessee, it again crosses the state line, returning to the commonwealth in which it takes rise,

> and flows on through the counties of Trigg, Lyon and Livingston, emptying into the Ohio at Smithland, in Kentucky . . ." (Cumberland River Improvement Association 1892: 17).

The Cumberland River begins about twenty miles to the north and east of Cumberland Gap, near the small town of Oven Fork in Letcher County, Kentucky. Here three streams, the Poor Fork, Clover Fork and Martins Fork, all sizable streams in their own right, join together to form the Cumberland. Because these three tributaries are quite large themselves the Cumberland comes into being as a full fledged river about 60 yards wide (Dupier, in Kleber 1992: 249; McCague 1973: xiii).

The Cumberland was a very different river before multi-purpose dams were constructed in the last half of the 20th century. It was often described as capricious, capable of sudden rises and falls, which caught the unwary or unknowledgeable navigator unawares. Numerous shoals dotted its course, the worst being Smith's Shoals, just above Burnside, and Harpeth Shoals, about 40 miles below Nashville. The description that follows describes the river as it was before any dams restricted its flow, and high dams altered its character. This is the river, which the Army of Corps of Engineers tried to subdue, in some small fashion, by building a series of locks and dams between 1888 and 1928.

The Cumberland River travels almost 700 miles in a course described as "extremely winding and irregular," "serpentine," "very crooked" and "devious and eccentric," draining an area of 18,000 square miles. The terrain in the upper part of its course, above Burnside, is mountainous and very broken, and the river is contained between steep cliffs of conglomerate and sandstone, which rise 300 to 500 feet above the river. Numerous creeks with rough and stony banks, some good-sized streams, like the Laurel and Rockcastle Rivers and Buck Creek, and some little more than gullies carved by the run-off of heavy rains, flow into the Cumberland in its upper reaches, draining an area of 2,500 to 1,500 square miles. At Burnside the Cumberland receives its first important tributary, South Fork, which drains 1,200 to 1,500 square miles of land. This portion of the river falls steeply all along its course, but the principal fall is concentrated at two points – Cumberland Falls and Smith's Shoals. At Cumberland Falls the river drops dramatically, falling 68 feet over a rock ledge. At Smith's Shoals, just above Burnside, the fall is scarcely more contained, the river dropping 55 feet in about eight miles (Annual Report of the Chief of Engineers 1891: 2267; Douglas 1961: 388; Dupier, in Kleber 1992: 249; King 1924: 39-40; McCague 1973: xiv; Toplovich, in Van West 1998: 227-228).

Between Burnside and Nashville the terrain is somewhat gentler. The river is bounded alternately on one side by high rocky hills and on the other by a low, flat, and very fertile floodplain, several hundred feet in width. The fall of the river between Burnside and Nashville is relatively uniform, averaging about eight inches for every mile. Between Burnside and Celina, a distance of 135 miles, several tributaries flow into the Cumberland, the principal one being the Obey River that drains several hundred square miles of the western slope of the Cumberland Plateau and enters the river just above Celina. Near the Kentucky-Tennessee line the river enters the Great Central Basin of Tennessee. Between Celina and Carthage, about 75 miles, the most important tributary is Caney Fork. The Caney Fork, which drains an area of 2,000 square miles, more than any other individual tributary in the Cumberland system, is perhaps the most important in influencing the unpredictable Cumberland. The sources of the Caney Fork are located on the western slopes of the Cumberland plateau, and almost to the western edge of the eastern Highland Rim. For most

of its course this stream is rapid flowing and drains rapidly as well, forming a very important component in the stages of the Cumberland River from Carthage on down. Below Carthage is Stone's River, which rises in the foothills of the eastern Highland Rim. Stones River, which drains an area of about 1,300 square miles, enters the Cumberland fourteen miles above Nashville (Douglas 1961: 388-389; Dupier, in Kleber 1992: 249; King 1924: 39-40; McCague 1973: xiv; Toplovich, in Van West 1998: 227-228).

The terrain bordering the river below Nashville is characterized by a wider flood plain and lower hills than the river above the city. The gradient of the river is less too, with the fall averaging just six inches to the mile. Below Nashville there are two principal tributaries, the Harpeth River and the Red River. The Harpeth River enters the Cumberland from the south, just below where it cuts its way into the Highlands. It is at this point that Harpeth Shoals forms a difficult barrier to navigation. The Red River parallels the Cumberland, its course taking it almost entirely through the Highlands, until it enters the Cumberland from the north just below Clarksville. Down river from Clarksville numerous small tributaries join the Cumberland but none of any real importance (Douglas 1961: 389; Dupier, in Kleber 1992: 249; King 1924: 39-40; McCague 1973: xiv; Toplovich, in Van West 1998: 227-228).

Early Exploration of the Cumberland Basin

The first to navigate the Cumberland were, of course, the native peoples who lived in the region. Knowledge of the earliest peoples is found in the archaeological sites, which line the banks of the river. When Europeans recorded their first voyages to the Cumberland Valley they told of peoples traveling the Cumberland on improvised rafts and in dugout canoes, or pirogue, hollowed by fire and adze from the trunks of cypress, cottonwood and other large trees. The largest of these might be fifty feet long and five feet across at the beam, capable of carrying thirty men or fifty tons of cargo. Many groups made use of the Cumberland basin, an area with immense herds of deer and buffalo. Bear, Passenger pigeons and turkey were found in abundance. The Cumberland basin also had other resources necessary for survival – clay for pottery, chert for tools, medicinal and edible plants. The Shawnee, driven from their homeland north of the Ohio River by the Five Nations of the Iroquois, settled around the big salt lick, now the heart of Nashville, where game gathered. The Cherokee and Creek made use of the valley and the Chickasaw, who lived along the bluffs of the Mississippi to the west, made forays into the area. All of these peoples opened trails, established small settlements, hunted game along the river and fished its waters. The Cumberland River was the artery of travel for these early inhabitants. Providing access to the Ohio, Tennessee, and Mississippi it "afforded a water highway of matchless beauty and gave an unlimited sphere of action to traveler, trader and warrior" (Douglas 1961: xi; Johnson 1978: 6).

Among the first Europeans to record the existence of the Cumberland were Louis Jolliet and Jesuit Father Jacques Marquette. In 1673 they met at Fort Michilimackinac, located on the northern tip of Michigan's lower peninsula, to begin a long journey. They had been ordered by their superiors in Quebec to explore the river known as the Mitchisipi, or Meshasabi, and what we now know as the Mississippi. Upon his return to Quebec in the summer of 1674 Father Marquette drew a map of the Mississippi and its tributaries from memory. He drew the Ohio, which he called the Ouabouskigou, in proper relation to the Mississippi but showed it jutting

eastward into limbo, for he had no knowledge of its course. He drew one tributary for the Ohio, showing it as hanging south from the larger river. He did not label this river with a name but did indicate a large village of "Chauouanons" close to its junction with the Ohio, indicating that the river was, indeed, what we now know as the Cumberland. The Chauouanons were known to the English as the Shawanons, Shawanoes or Shawnees. In the late 17th century fugitive bands of the Shawnee were moving south and east, having been forced from their homelands north of the Ohio by the Five Nations of the Iroquois (McCague 1973: 12-13).

Within a short time other French maps began to show the river, and somewhere along the line a French mapmaker labeled it the *Rivière des Chauouanons*, a title it was to carry for some years. The first European to actually look upon the Cumberland may have been an Englishman named Gabriel Arthur, a bond servant to the prominent Virginia businessman Abraham Wood, who in 1673 accompanied an expedition to a large town of Cherokee on the Little Tennessee River. Gabriel spent many years with the Cherokee and then the Shawnee, not all of it of his own choosing, and from tales of his wanderings is known to have crossed the Cumberland River on at least two occasions. On his return to Virginia many years later he was directed by the Shawnee to the Warriors Path of Kentucky, the *Athawominee* or Path of the Armed Ones. He followed the well-blazed, well-trodden path through the mountains, crossing the Cumberland River and passing through a broad gap with a cave on one side, Cumberland Gap. But Arthur's tales of the river and the broad gap through the mountains seems to have been largely ignored, and it would be half a century before another party ventured into the wilderness beyond the mountains (McCague 1973: 15-19).

While Englishmen ignored the west the *coureurs de bois*, or wood runners, of New France were exploring the rivers in bateau and pirogues and establishing trading outposts in the wilderness. One of these men was Martin Chartier, a Frenchman who had deserted from LaSalle's forces, and the first European known to have navigated the Cumberland. Chartier married a Shawnee woman and traveled south with the tribe to Big Salt Lick, or French Lick as it also came to be called. He lived on the Cumberland for three years and as early as 1692 went up the Cumberland to just below Cumberland Falls and then overland through Cumberland Gap into Virginia. He and his son later returned to French Lick where they were known as "white Indians" (Douglas 1961: xii).

Legend has it that another of these intrepid woodsmen, Jean du Charleville, took a bateau-load of furs up the river from the settlement at French Lick to the Ohio and down the Mississippi to the Gulf in 1714. If the story is true he was the first in a long line of French hunters and traders to navigate the Cumberland to the Ohio and down the Mississippi. It is known that he often traveled the Cumberland, trading with the peoples living along its banks. Sometime not long after 1717 Guillaume Delisle, court geographer to King Louis XIV, drew a map containing all that Frenchmen knew or surmised about North America. The Cumberland was drawn as a very large river, larger than either the Tennessee or the Ohio, which flowed east to west in a relatively straight line. He gave it the name *Rivière des Anciens Chauouanons*, for, as he explained, "the Chauouanons who lived here in other days" (McCague 1973: 22). And in that assumption he was not wrong, for human use of the river is known to have begun toward the end of the last ice age. On almost every terrace along the Cumberland may be found evidence of occupation, from

Paleo-American hunting camps to Mississippian settlements (McCague 1973: 21-22; Toplovich, in Van West 1998: 227).

The Loyal Land Company of Virginia held a grant for eight hundred thousand acres of good western land from King George II. One of the prime movers in the company was Dr. Thomas Walker who hoped to find that land in a place he had heard of called Kentakee, which he understood to mean a place of fertile, well-watered plains. Since the early 1700s adventurous souls had been making their way through the Blue Ridge Mountains and settling on scattered farms in Virginia's Great Valley. When Dr. Walker left his home on March 6, 1749 with five companions, seasoned woodsmen all, they were able to find shelter at some settler's cabin almost every night. Two weeks after leaving home the party reached the home of an old acquaintance of Dr. Walker's, Samuel Stalnaker, whose farm was the farthest outpost of settlement in Virginia, and would be for some time to come. Stalnaker gave directions to the party, which led them eighteen days later to Cave Gap, as Stalnaker knew it. Walker found the path clearly blazed and the party camped that night on Yellow Creek, which he named Flat Creek. Over the next few days the party followed the creek in its course down the gap's northward slope. On April 17 Walker wrote in his journal "Still rain. I went down the Creek a hunting and found that it went into a River about a mile below our Camp. This, which is Flat Creek and some others join'd, I called Cumberland River" (McCague 1973:23-26).

Dr. Walker had been introduced to the Duke of Cumberland, second son of King George II and Queen Caroline, while on a trip to England some years earlier and the introduction had no doubt made an impression. Also fresh in the minds of loyal Englishmen like Walker was Cumberland's route of the Jacobite pretender Bonnie Prince Charlie Stuart just a few years earlier, in 1746. In any event, with no further fanfare the river received the name it still bears – Cumberland. In 1750 Dr. John Mitchell, another early explorer, issued his map of the region, which he had drawn with the assistance of Dr. Walker. His is the first map known to have included the name "Cumberland" for the river. Although a few maps issued after that time, such as James Adair's, referred to the river by other names, the name "Cumberland" gradually came into common usage (Douglas 1961: xii; McCague 1973: 26).

In 1760 the first of the next wave of explorers of the Cumberland Country arrived. They were Long Hunters, men like Elisha Walden, Uriah Stone for whom Stones River is named, Michael Stoner, Kasper Mansker, Thomas Sharpe Spencer and Obediah Terril who gave his name to the Obey River. In 1765 one of them, Henry Scaggs, became the first European to navigate the Cumberland from its upper reaches down to French Lick. The Long Hunters came to hunt, not to settle. Many traveled the Cumberland, some in the employ of large eastern companies such as the Philadelphia trading house of Baynton, Wharton & Morgan who shipped enormous amounts of salted venison and buffalo tallow down the Cumberland and on to markets in New Orleans. The days of the Long Hunters were brief. No amount of game could withstand the relentless hunting where animals slaughtered and skins taken numbered in the thousands. One of the last of the Long Hunters was Daniel Boone. Toward the end of his first, and only, long hunt he set up camp on the banks of the Cumberland River, in the area now occupied by Lake Cumberland, and stayed the winter of 1770-1771 (Douglas 1961: xiii; Durham and Thomas 1986: 6; McCague 1973: 32-41).

Joseph Hollingshead, employed by a large Philadelphia trading house, arrived on the Cumberland in 1768 or 1769. He had come to supervise the killing of game and packing of meat in casks for the New Orleans market and for the garrison at Fort Chartres, in what is now Illinois. Hollingshead employed twenty large pirogues in his activities, marking the beginning of commercial transportation on the Cumberland (Douglas 1961: xiii-xiv).

One of the first to settle on the Cumberland was Jacques Thimote de Monbruen, a French-Canadian hunter and trader who came up the Cumberland for the first time about 1763. De Monbruen made numerous trips to the Big Salt Lick after that time and eventually settled there, living in a cave near the mouth of Mill Creek. He was still living in the area when Nashville was settled and he became one of the town's most popular citizens. De Monbruen later told a friend that the hunting was so good when he first arrived at French Lick that he loaded a flatboat with hides and tallow and set out for New Orleans. While that may be true, the first man known to have made the hazardous voyage down the Cumberland and then down the Mississippi to New Orleans was Jacob Sandusky, in 1774 (Douglas 1961: xiii; McCague 1973: 56-57).

Capt. James Robertson journeyed to French Lick with a party of eight in 1779, discovering de Monbruen's cabin, which was full of buffalo tallow, though the owner, being absent from the area, was nowhere to be found. In what seems to have been a hasty decision, four of the group stayed at French Lick to clear a small patch of ground, plant corn and set up a permanent or semi-permanent station (Douglas 1961: xiii; McCague 1973: 56-57).

That fall several parties of settlers set out toward the French Lick with the intention of settling, including a group led overland by James Robertson. The majority of the Robertson group was traveling by flatboat under the leadership of Col. John Donelson. Donelson's trip was one of huge proportions for that day and time. He was heading a flotilla of thirty boats, carrying one hundred fifty settlers, their wives, children, slaves and all of their household goods. Their craft were flatboats, "cumbersome, square ended arks as long as thirty or forty feet or more, with the homely virtues of cheapness, ease of construction, shallow draft, and immense carrying capacity" (McCague 1973: 58). They left Fort Patrick Henry on December 22, 1779. They were to travel down the Holston and Tennessee Rivers to a point south of Big Salt Lick where they would be met by Robertson, who would lead them to the settlement (Douglas 1961: xiv; McCague 1973: 60).

When the Donelson party set off down the Tennessee they believed that the river lay no more than thirty miles south of the French Lick, when in fact it was more than one hundred miles. Robertson never met the party of flatboats; he became lost on the Duck River, thinking it was the Tennessee. With no one to guide them to the settlement Donelson was left with little choice. He took his group down the Tennessee to the Ohio. It took them four days to battle the current of the Ohio to reach the mouth of the Cumberland, and over a month to travel up the Cumberland to French Lick. They arrived April 24, 1780 after fighting the spring tides in the river, forcing the clumsy, heavily laden flatboats against the current with poles, oars, thick towropes and dogged determination. The importance of Donelson's epic voyage up the Cumberland cannot be overemphasized. It was a landmark in the history of the Cumberland, blazing the way for the flatboats, keelboats and barges, which soon appeared on the Cumberland in large numbers (Douglas 1961, xiv; Johnson 1978: 10; McCague 1973: 58-63).

When Donelson and others like him set off on their journey they had no maps to guide them, no way to know the course of the Cumberland and the Tennessee or their relation to each other. But at least one accurate map did exist. In 1769 Lieut. Timothy Hutchins, Engineer of the British Army, had mapped both the Tennessee and the Cumberland. Hutchins, who had been born in America, entered the service of the King about 1762. In 1769, while assigned to Fort Kaskaskia, Hutchins was ordered to patrol the tributaries of the Ohio in the hopes of curtailing the activities of foreign traders violating British territory, principally the Spanish. A bateau was transformed into an armed galley by raising the sides and installing a six-pound brass cannon. The *Gage*, as she was named, was propelled by twenty-four oars, and could carry thirty-five men and enough supplies for a six-month journey. As Hutchins and his crew patrolled the western rivers he kept detailed notes on topography, terrain and navigational problems. With a compass and crude instruments he estimated distances and made sketches. In spite of the difficulties of estimating distances and direction during night travel Hutchins was able to create remarkably accurate maps of both the Tennessee and the Cumberland Rivers. He said of the Cumberland, which he called the Shawanoe, " [it] empties itself on the eastern side of the Ohio, about 95 miles southwardly of the Wabash. It is 250 yards wide at its mouth, has been navigated 180 miles in Battoes [sic]. . . and from the depth of water, at that distance from its mouth, it is presumed may be navigated much further" (Johnson 1978: 4). It is not known how far Hutchins took his patrol up the Cumberland, or how much information he received from others. What is certain is that his work brought him immediate recognition. He was elected to the American Philosophical Society and by the time of the Revolution had been elevated to the rank of Captain in the British Army (Douglas 1961: xiv; Johnson 1978: 1-6; McCague 1973: 59).

In 1777 Hutchins was in London arranging for the publication of his topographical maps and descriptions. At the outbreak of the Revolution his loyalties were divided. He had no wish to take part in a war against his countrymen, yet all he had was his commission in the British Army as an officer and an engineer. While in London he was contacted by American secret agents. The correspondence was discovered and Hutchins charged with high treason. Although the charges were later dropped Hutchins cut all ties with Britain, fleeing to France where he met with Benjamin Franklin and offered his services to the Continental Army. He was assigned to the army of General Nathanael [sic] Greene and given the title Geographer of the United States of America. But Hutchins' maps remained in London. It would be many years after the end of the war before they were made available in America. So it was that Donelson and other settlers to the Cumberland Valley had nothing to guide them in their journey to a new land (Douglas 1961: xiv; Johnson 1978: 1-6; McCague 1973: 59).

Early Commerce on the Cumberland

The flood of settlers to French Lick, or Nashborough, as it became with the signing of the Cumberland Compact in 1780, continued unabated. In 1784 Nashborough became Nashville, probably as the result of the anti-British feelings that ran high after the Revolutionary War. By 1800 Nashville was a thriving city and barge and keelboat transportation was one of its largest enterprises. John Coffee, George Poyzor, Christopher Stump and Mssrs. Rappier, Turner and Spriggs and others like them shipped tobacco, corn, indigo, hogs, horses, flour and cotton from

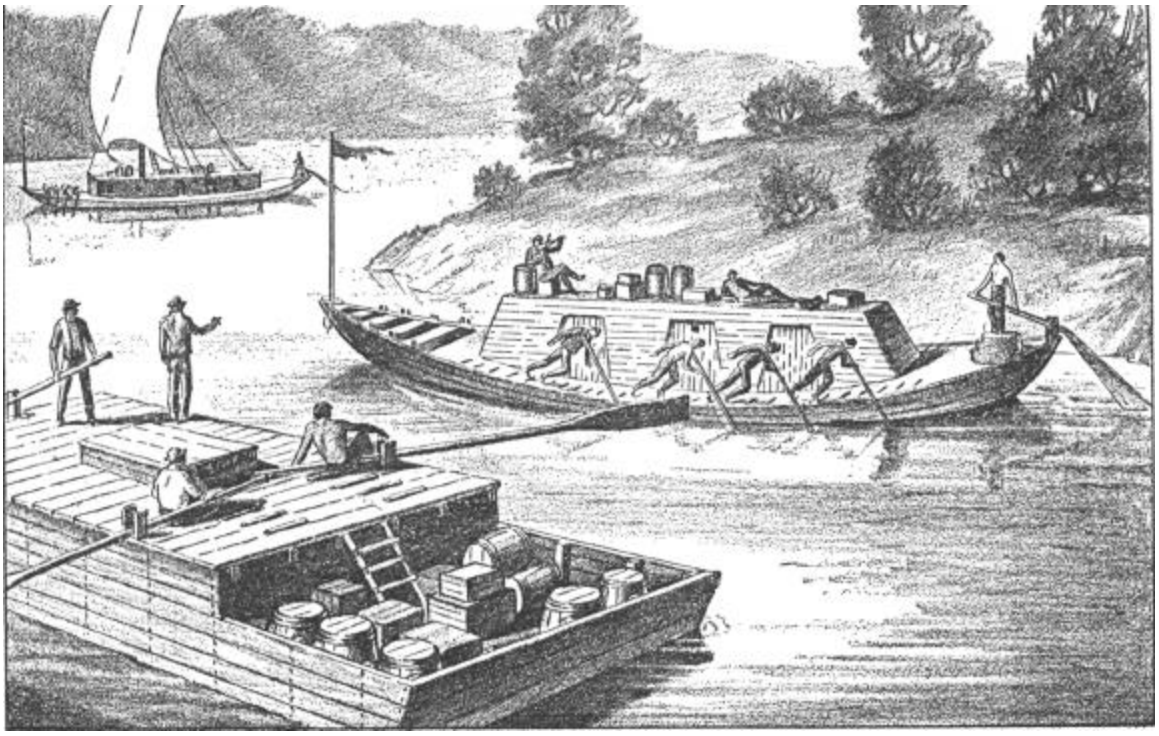


Figure 1: Flatboats and keelboats on the western waters.

Nashville and Clarksville to New Orleans on a regular schedule (Douglas 1961: xiv; Paine, in Van West 1998: 669).

The earliest commercial craft was the flatboat, or one of its variations. Known as arks, broadhorns and Kentucky boats, the flatboat was simply a large sturdy box with flat sides pitched slightly outward. For long journeys a roof might be added to protect passengers and cargo. In cold weather a stone fireplace might be added, for heat and cooking. A visitor to the area in 1802 described them thusly: ". . . of a square form, some longer than others; their sides are raised four feet and a half above water; their length is from fifteen to fifty feet; the two extremities are square, upon one of which is a kind of awning, under which passengers shelter themselves when it rains" (Johnson 1978: 13).

As the population increased floating stores and shops appeared on the river. Entrepreneurs included blacksmiths, liquor dealers and dry goods merchants. Libraries, wax museums, thespian troops and "floating mansions of iniquity" plied the Cumberland. Preying on river travelers were bandits and river pirates. "Boatwreckers" offered their help navigating a shoal and then deliberately wrecked the boat, helping themselves to the cargo as it was "salvaged." The two thousand mile journey to New Orleans was fraught with danger and peril – storm, high tide, low water, snag and reef. The overland trip from New Orleans via the Natchez trace was just as bad. Bandits patrolled its length, ready to relieve hapless travelers of their money, and perhaps their lives. In spite of the dangers the flatboat trade flourished. Produce was brought from as far up the Cumberland as the mouth of the Little Laurel River, which was designated an official United States port of entry (Johnson 1978: 13-15; McCague 1973: 93).

The advent of the keelboat soon after 1800 radically changed commerce on the Cumberland. Keelboats, keels or barges were constructed on a heavy timber keel, with a frame ribbed like a ship and planked over. They were long, sleek, possessed a light draft and, unlike the clumsy flatboats, could navigate upstream. That is not to say that it was an easy proposition to take a keelboat against a swift current. A strip of decking about fifteen inches wide ran the length of the boat. Here, those manning the poles would stand to propel the boat forward. When poling was of no avail towlines were attached to the bow and the boat simply pulled along, or the lines were anchored upstream around a tree and the boat pulled by hauling hand-over-hand on the line. Work on a keelboat was backbreaking, exhausting and dangerous, but also exciting with the promise of new places and experiences; reasons enough for many a young man to be lured to the life of adventure on the river (Johnson 1978: 16-17).

The *Mary Jane* was typical of keelboats operating on the Cumberland. She was built in Cincinnati and fitted with masts, spars and sails. Eighty-two feet long and fifteen feet wide, she carried a crew of twenty-two and was capable of carrying fifty-seven tons of goods from New Orleans to Nashville in twenty-seven days. In 1804 Andrew Jackson ordered goods for his stores and a harpsichord for Rachel from Philadelphia. It came overland to the Ohio, and down the Ohio to the Cumberland on a keelboat. From the mouth of the Cumberland to Nashville the keelboat trip took sixteen days. Jackson's freight bill was $1,600, which included the cost of twenty gallons of whiskey to keep fourteen keelboatmen happy on the long upstream haul up the Cumberland. Sailing ships could also be found on the Cumberland in the early years of the 19th century, most notably at the ports of Cairo, Tennessee and Eddyville, Kentucky. These schooners and brigs might be sixty-five feet long and twenty feet wide, with a carrying capacity of 75 tons. They were often built to be sailed to New Orleans where they were sold for coastal and foreign commerce (Johnson 1978: 16-18; McCague 1973: 145).

In 1814 Zadoc Cramer, in his *Pittsburgh Navigator and Almanac*, a combination travel guide and pilots' handbook for the Ohio and Mississippi rivers and their navigable tributaries, heaped lavish praise upon the City of Nashville and was equally enthusiastic about the city's river commerce: "There is a line of barges constantly running from Nashville to New Orleans, loaded down with the rich products of Tennessee and up with sugar, coffee, rice, hides, liquor, dry goods, etc . . ." But by 1814 steamboats were no longer a rarity on the Ohio and the Mississippi and Cramer concluded his remarks by saying "Boats conducted by the steam principal would most probably be more advantageous and save immense manual labor. The day is not far distant I hope, when the citizens of Nashville, will see a steam boat winding her course up the Cumberland, in all the majesty and nobleness of her internal and secreted power, without the assistance of poles, oars or sails. It wants nothing to do this but the spirit of beginning." It would be five years before a steamboat would sail into Nashville, but it would not be from lack of trying (Douglas 1961: 1, 8).

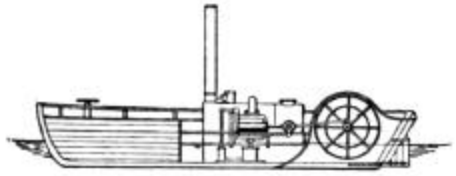


Figure 2: An early steamboat design

As commercial traffic on the Cumberland increased so did complaints about the condition of the river. In its natural state the Cumberland was practically impassable at low water. Rocky shoals, rapids and sand and gravel bars were some of the worst impediments. During high-water projecting boulders and snags

waited to catch unwary boatmen. Snags were among the most feared of navigation obstacles, often waiting unseen. Rivermen had names for the various types of snags. Planters were fixed to the bottom by their roots, their upper ends pointed up, ready to impale the unwary vessel; sawyers were planters whose free ends bobbed and swayed with the current; while sleeping sawyers lurked beneath the surface, ready to stave in a boat's hull. Not all impediments to navigation were natural, however. Dams built to power gristmills and sawmills were especially numerous on the river's tributaries. The conflict was plain. Rivermen wanted navigable waterways. Roads were practically non-existent in the western frontier; the river and its tributaries were the highways that connected the towns along their banks. But waterpower was about the only mechanical power available until the advent of steam. It was a conflict that would stay unresolved (Johnson 1978: 21).

John Sevier, Governor of Tennessee from 1796 to 1809, believed that navigation on the rivers was the "natural and inherent right of this state." Upon his urging the General Assembly granted charters to private companies to perform work on the rivers. In return they were allowed to sell stock and to charge tolls on the sections of the river they improved. But little seemed to have been accomplished under this system and by 1815 then Governor Joseph McMinn was suggesting direct appropriation for state funds for river navigation. By 1819 funds derived from the sale of public lands were being applied to improve the Tennessee and the Holston Rivers, though not the Cumberland. Advertisements run by the board of commissioners proclaimed: "We . . . now offer fifteen dollars per month for able bodied men. We will find them with good wholesome diet, and one pint of whiskey per day. It may be well for each one to bring a blanket" (Johnson 1978: 26). About the same time Kentucky tried similar inducements for improving the several rivers, including the Cumberland. The $40,000 appropriated was spent within the year. In neither state were any noticeable improvements forthcoming. But a force was now plying the western rivers that would make improvement of the rivers an economic necessity – the steamboat (Johnson 1978: 25-26).

Steamboats Come to the Cumberland

The *New Orleans* was the first steamboat to make a successful voyage from Pittsburgh to New Orleans. It was amazing that the voyage was completed at all. In December 1811, during the maiden voyage of the *New Orleans*, the New Madrid earthquakes shook the region. During this series of earthquakes Reelfoot Lake was created in twenty-four hours and the course of the Mississippi was altered, beyond recognition in some places, over a distance of 200 miles. The voyage of the *New Orleans* silenced forever those who said that a steamboat could never master the swift currents of the western rivers. Three years later steamboats were no longer a rarity on the Mississippi and the Ohio. When Zadoc Cramer expressed his wish to see steamboats on the Cumberland and docked at Nashville it seemed only a matter of time before such a sight would be commonplace (Douglas 1961: 2-3; Johnson 1978: 27).

Early in 1818 the steamboat *General Jackson* was launched in Pittsburgh. She was owned by Gen. Carroll and Mr. Whiting of Nashville, and Nashville was her port of registry. The boat arrived in Louisville March 15 and continued onto New Orleans, reaching the Crescent City on April 18. On her return voyage the *General Jackson* steamed up the Cumberland but was only able to navigate the river as far as Cross Creek, ninety-five miles below Nashville, before being

halted by low-water. A year later the *General Jackson* again attempted to reach her homeport, only to be stopped at the lower end of Harpeth Shoals, the worst stretch of water on the Lower Cumberland, 38 miles below Nashville. The boat had been stranded for several days when the captain ordered the crew to unload her cargo. When they had nearly finished the Cumberland experienced one of its sudden, and unpredictable, rises and the boat was able to continue on to Nashville, steaming into port March 11, 1819, the first steamboat to reach Nashville (Douglas 1961: 2-3, 9; Johnson 1978: 27; McCague 1973: 146).

One witness recalled the arrival of the *General Jackson*: "The whole population, men, women and children, collected on the bank of the river and loud cheers rent the air. As long as she remained in port, she was the object of curiosity to thousands who came from far and near to behold this wonder of the waters" (Douglas 1961: 8). But the *Nashville Whig and Tennessee Advertiser*, after praising the General Jackson, had this to say in an editorial which appeared Saturday May 1, 1819: "This fine boat has given us but one visit since she has been in action and it is not because she is displeased with Nashville; but it is because we have done nothing to remove the small obstructions in the navigation of our rivers. It is hoped the next legislature of Tennessee, will make a law, with provisions and requisitions permitting steamboats to pass to Nashville, at all seasons of the year" (Douglas 1961: 7-8).

In spite of the admonishments of the press very little was done to improve the river over the next decade. Harpeth Shoals continued to be a dangerous obstacle and many steamboats were damaged or sunk trying to cross them, including the *General Jackson*, which went down in 1821. The moody Cumberland experienced sudden rises, and sudden drops. Once stuck on the shoals a boat was there until a high tide floated her off. Impatient captains might try "hogging through," a process in which the entire crew, deckhands, roustabouts, mates, engineers, cooks, firemen and sometimes even the male deck passengers, went over the side to shovel mud and gravel and literally "root her out like a hog" (McCague 1973: 147). Some larger boats never attempted to cross the shoals, but simply transferred cargo and passengers to smaller boats for the remainder of the trip to Nashville. One old timer remarked years later that every gravel in the Shoals stood for a 'cuss' word. Harpeth Shoals would remain an obstacle until Lock A was put into service in 1904 (Douglas 1961: 9-10; Johnson 1978: 28, 30-32; McCague 1973: 147).

Despite Harpeth Shoals and other navigational problems by 1824 there were over a dozen steamboats engaged in trade on the Cumberland. Steamboats dramatically lowered the cost of transportation, a savings passed on to consumers. Over one year's time sugar went from twenty-four cents to nine cents a pound, coffee from fifty to twenty-five cents a pound and salt from three dollars to seventy-five cents a bushel. Luxury goods came to the Cumberland Valley in the hold of a steamship. In 1829 the *Lady Washington* arrived from New Orleans bearing "superior Jamaica coffee," "Baltimore oysters," pepper, fresh almonds, sperm candles, "assorted Cordials" and "Champaign [sic] wine." More prosaic items were carried as well, including pig iron, which was being shipped to mills in Pittsburgh by 1830 (Douglas 1961: 9-10; Johnson 1978: 28, 30-32; McCague 1973: 147).

Between 1830 and 1840 steamboat traffic increased dramatically on the Cumberland. During that decade 164 different steamboats were engaged in trade on the river. Nashville became the dominant river-borne transportation facility in Tennessee, and the chief distribution point for

commerce moving from the west and mid-west to the southeast. While trade increased on the Lower Cumberland steamboat pilots and owners continued to push the limits of navigation on the Upper Cumberland. By 1828 some of the smaller packets had gone as far as the mouth of Caney Fork. A few years later, bold pilots pushed past Martinsburg, just over the Kentucky line, and through Wild Goose Shoals to Rowena Landing. On April 13, 1833 the *Jefferson*, under the command of Capt. E. S. Burge arrived at Nashville from Point Isabel (now Burnside) with a cargo of tobacco, the first boat to navigate the river from that point (Douglas 1961: 9-10, 35-4; Johnson 1978: 32-37; McCague 1973: 148).

In spite of the increased traffic, and increasingly vehement demands for river improvement, little was accomplished. Tennessee initiated a program of internal improvements in 1829 with a view toward opening the Upper Tennessee River, above the impassable barrier of Muscle Shoals, to navigation but the effort foundered in a tangle of sectional jealousies. So unable were different areas to reach a consensus that multiple boards of improvement sprang into being, one for practically every navigable waterway in the state, and some were even established for different counties (Douglas 1961: 9-10, 34; Johnson 1978: 32-36).

In spite of the dissention towns all along the river were anxious that the Cumberland be improved so that they might gain the advantage of river transportation. There might be little agreement as to who should be responsible or how improvements should be made, but there was agreement that the Cumberland needed improvements. Much of the controversy revolved around the role of the state in such matters and what help, if any, should be obtained from the Federal government. Andrew Jackson, Tennessee's native son, was elected to the presidency in 1828. Jackson had a long history of association with the Cumberland. His business success was tied to the river and his home, "The Hermitage," was situated on its banks. Supplies sent from the Cumberland Valley to New Orleans in 1814-1815 had helped him defeat the British at the Battle of New Orleans, which helped pave the way to the presidency. After his election the Tennessee legislature reminded Jackson of the value of the Cumberland River. Whether this was the reason or not no one knows, but it was during Jackson's first term that improvements to the Cumberland by the Federal government, represented by the Army Engineers, began. Although the River and Harbor Act of 1832 provided only a small appropriation for work on the Cumberland it was seen as a beginning (Douglas 1961: 35-4; Johnson 1978: 37, 61; McCague 1973: 148).

Improvement of the Cumberland Begins

The River and Harbor Act of 1832 designated $30,000 for the improvement of the Cumberland, specifying only that it be expended under the direction of the War Department. In September 1832 Capt. Henry M. Shreve, Superintendent of Western River Improvements for the Engineer Department, and Capt. Richard Delafield, Corps of Engineers, surveyed the Cumberland from its mouth to Nashville by the simple expedient of making observations from the deck of a steamboat on the round trip to and from Nashville. Their joint report listed four varieties of obstacles: dense growths of tangled timbers overhanging the channel, snags embedded in the river bottom, isolated rocks and reefs, and shallow shoal waters. They recommended clearing away the timber, removing the snags, blasting away rocks and rocky reefs and constructing longitudinal wing dams at the shoals to confine the channel and increase its depth. William McKnight, a steamboat

captain, was chosen to supervise the work and was given the title "Superintendent of the Improvement of the Cumberland River" (Johnson 1978: 61-63).

McKnight tackled the improvement with gusto. He initiated the work as soon as possible, buying supplies with his own money (he was later reimbursed) and gathering a crew of about fifty laborers. Between October 16 and December 7, when high water forced work to stop, the laborers cleared timber and removed logs from sandbars between Harpeth Island and Nashville. In 1833 the steamboat *Virginia* was transferred to the project to tow scows for moving stone and the machine boats for pulling snags. Over the 1833-1834 low-water season the workmen cleared the banks of driftwood down river to Camp Rowdy (near Kuttawa, Kentucky), raised a number of wrecks from the channel, blasted rock and built wing dams at the shoals (Johnson 1978: 63-65).

In 1834, yielding to the persistent urging of citizens on the Upper Cumberland, Congress directed a survey of the upper river from Nashville "to the highest point on said river susceptible of being made navigable for steamboats" (Johnson 1978: 65). Howard Stansbury, United States Civil Engineer, was ordered to Nashville where he began his survey August 8, 1834. Stansbury was impressed with the river, and with the natural products of the river valley, especially coal. He found twenty-five mines, employing almost 300 men, in operation near the mouth of the Laurel River. The coal trade was increasing and coal was loaded onto flatboats and floated down to Nashville on the spring tides. In 1834 Stansbury saw 100 flatboats being readied for spring. He believed that this trade alone could justify improvement of the river to the mouth of the Laurel River and that it should be considered the head of navigation for the Upper Cumberland (Johnson 1978: 65-66).

Stansbury divided the upper river into four section and made recommendations for each. The uppermost, Cumberland Falls to the mouth of the Laurel River, was closed to navigation at low-water by huge boulders, while in high-water was a violent, raging torrent "presenting a scene at once of terror and the wildest magnificence" (Johnson 1978: 66). He believed that improvement here was impractical, given the expense and difficulties, but stated that improvement might be necessary in the future because of the vast mineral reserves found there and the potential power which could be generated by the falls. The major obstruction in the second section, from the mouth of the Laurel River to the mouth of Big South Fork, was Smith's Shoals. Here the river fell fifty-four feet in less than six miles. Numerous coal barges entered the shoals each year only to be lost with their cargo, and sometimes their crew. Stansbury came up with five ways to improve this stretch of river but rejected four of them, including a slackwater system of locks

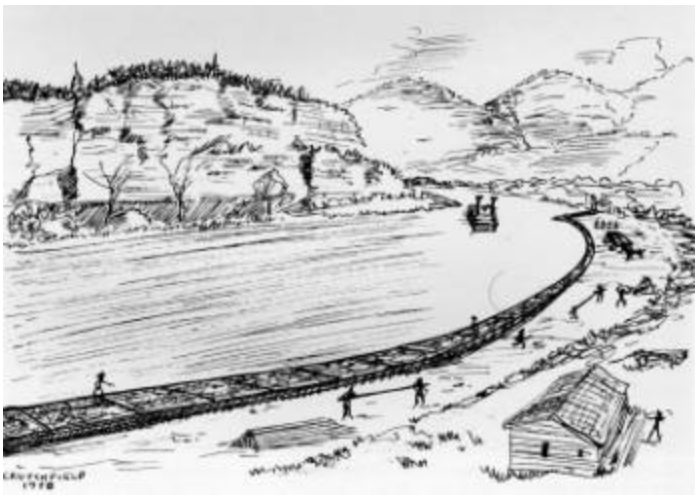


Figure 3: Construction of a wingdam on the Tennessee River in 1832.

and dams, as too expensive. His final recommendation was that wing dams be built perpendicular to the current to gather the waters and force them into a regular channel, thereby increasing the navigable depth over the shoals. For the two lower sections, from Big South Fork to Nashville, he recommended mostly open-channel work; that is, snag, timber and rock removal, and the construction of a few wing dams at shoals. He estimated the total cost for the recommended improvements above Nashville to be $45,192.10. Congress accepted Stansbury's recommendations in 1837 and made an appropriation for the improvement of the Cumberland above Nashville (Johnson 1978: 67).

Capt. McKnight attacked his added duties on the Upper Cumberland as energetically as those on the lower river. He deployed laborers at the mouth of the Laurel River and Carthage to clear timber from the banks. He acquired the *Laurel*, one of the steam-powered snag boats developed by Captain Shreve, and set it to work around Carthage. In 1838 McKnight had 130 men employed in improving the Cumberland, doing everything from cutting trees to blasting rock and building dams. Col. Stephen H. Long, Topographical Engineer, assumed overall direction of the Cumberland River Project in early 1839 and, after an inspection tour, praised the work McKnight had accomplished as an immense benefit to navigation. But Col. Long ultimately recommended the abandonment of the open-channel projects that were planned and recommended instead the construction of a system of locks and dams, a slackwater, canalization project. Long was convinced that the benefits would greatly exceed the costs of such a project. Col. John James Abert, Chief of Topographical Engineers, endorsed Long's recommendations and requested $5,000 from Congress to conduct a survey to plan the project. But the funds were not forthcoming, nor were any funds to complete the improvements then underway. From 1832 to 1838 Congress had appropriated $100,000 for improvements of the Lower Cumberland and $55,000 for improvements to the Upper Cumberland. Congress would not authorize further improvement of the river for over thirty years – until 1871 (Johnson 1978: 67-74).

There were several reasons for the change in attitude toward improving the Cumberland. President Martin Van Buren, who succeeded Jackson in 1837, was vehemently opposed to Federal civil works, or internal improvements, programs. Improvements on the Cumberland, along with most other Federally subsidized works projects in the country, came to an abrupt halt in 1839. From that point forward the internal improvements program blossomed or withered with each change of administration. During the Tyler administration, 1841 to 1845, improvements were made to some of the inland waterways, but not the Cumberland. Another contributing factor was the Panic of 1837, which was well underway by April of that year. Feverish land speculation, bad banking practices, unwarranted optimism concerning the stock market, a fall in the price of cotton and Jackson's "Specie Circular" combined to bring on panic, bank failures, factory closings and unemployment. Farms, plantations and cities were affected. Van Buren's removal of federal funds from selected state banks, some already in default, only made matters worse. The panic bankrupted many state governments. The depression continued unabated until 1841 and took even longer to recede in the South and West (Alden 1963: 316-317; Johnson 1978: 74).

In spite of the nation's financial downturn steamboat traffic on the Cumberland and other inland rivers continued to grow. By 1845 steamboats on the inland waterways were entering into an era of unprecedented success. Steamboats were often the only means of commercial transportation

linking the seemingly unlimited resources west of the Mississippi and south of the Ohio. Between 1840 and 1850 steamboats became larger and more elaborate with every improvement available incorporated into their designs, becoming 'floating palaces.' Almost 250 different steamboats, from all parts of the country, plied the Cumberland River in this decade. While commercial trade and tonnage was increasing all up and down the lower river the increase on the Upper Cumberland was astonishing. The upper river was a steamboat paradise, at times originating more freight than the packets could handle (Douglas 1961: 57-59).

While the steamboat trade was booming the debate over the constitutionality of Federally funded internal improvements raged. Congress appropriated nearly one and a half million dollars for waterway improvement in 1846 but President James K. Polk vetoed the bill because he questioned its constitutionality. In 1848 Zachary Taylor and running mate Millard Fillmore ran, and won, on a platform that supported a program of waterway improvement. When Fillmore succeeded Taylor in 1850, after Taylor's death, he stated in no uncertain terms his belief that Congress had the authority to appropriate funds for internal improvement. During the Fillmore administration waterways improvements were revived. The Tennessee was given $50,000 in 1852 but politics prevented the plans for improvement from being carried out. The Cumberland, however, received none of this bonanza (Johnson 1978: 74-75).

By 1850 passionate Southerners were talking about secession and the desirability of creating an independent Southern republic. On the other side, Northern extremists were calling of the separation of the North from the South. In spite of growing political dissention the decade of the 1850s was one of growth and prosperity. These years were marked by the growth of the railroads on a tremendous scale, growth made possible by a ready supply of capital furnished largely by British investors and gold mines in California. The steamboat trade continued to grow as well, not yet threatened unduly by the railroads. The Cumberland was considered one of the major five water highways in America. It has been estimated that 400 different boats were plying the river in this decade, at least 341 of which landed at Nashville. The city itself supported thirteen separate packet lines. One million tons of freight, with an estimated value of forty million dollars, was transported on the river annually. The Cumberland acted as the major transportation artery for large portions of Kentucky and gave merchants and farmers to the south and southeast, in Georgia and Alabama, a market and distribution point for goods which Muscle Shoals denied them on the Tennessee (Alden 1963: 372,380; Douglas 78-91).

The prosperity of the 1850s was shattered in 1861 by the sound of guns at Fort Sumter. The Cumberland River became a highway of war, her banks studded with fortifications and scenes of conflict. Over the next four years Union Generals regretted, on more than one occasion, that the Cumberland, the Tennessee and other western rivers had not been improved in a manner that assured unimpeded navigation. As might be expected any improvement of the nation's rivers and harbors was suspended during the war. But the war had served to make apparent the necessity of improving navigation and had removed any question of the constitutionality of federally funded internal improvements. As Johnson puts it: "The eclipse of the state's rights segment of the Democratic party and the ascendancy of the Republican party, which strongly advocated a national program of internal improvements-civil works, opened the way for a vigorous and sometimes constructive policy of waterway development"(Douglas 1961: 99-181; Johnson 1987: 81-84; 101).

A New Era of Improvements

The Rivers and Harbors Act of 1866 marked a profound change in the civil works policy of the Federal government. Large appropriations were made with the single purpose of improving navigation. All pre-war projects were ordered resurveyed to determine if the anticipated economic benefits to commerce and navigation outweighed to cost. Neither the Cumberland nor the Tennessee was on the initial list of rivers to receive aid but that was quickly changed. Trade on both rivers was quickly renewed after the war. On the Tennessee the growth of the iron industry around Chattanooga and Sheffield, Alabama was largely responsible, while on the Cumberland it was the booming coal industry, which fueled the growth of river traffic. In 1868 Gen. Godfrey Weitzel, a bearded, battle scarred veteran of the Civil War who had won six brevets during his service, was put in charge of surveying the Cumberland, a task he had already undertaken on the Tennessee. In 1871 Weitzel assigned direction of the survey to Sylvanus Thayer Abert, son of John James Abert, one-time Chief of Topographical Engineers. The Abert-Weitzel report emphasized the importance of the coal traffic above Nashville. The improvements recommended were much the same as those undertaken by William McKnight forty years earlier. The Rivers and Harbors Act of 1871 provided only $30,000 for improvements but it marked a new era of river improvement, and the initiation of improvements by the Corps of Engineers that has continued to the present (Johnson 1978: 109-111).

Figure 4: Godfrey Weitzel

As open-channel work resumed on the Cumberland steamboats began to feel pressure from the railroads. When the Louisville & Nashville Railroad was chartered in 1850 steamboat men had seen the threat. Louisville was a major port. The proposed railroad would cut off freight moving down the Ohio, and once connected to other lines in Nashville, would negate the need for river traffic. But prior to the Civil War the railroads had posed little threat. There was still very little track in the south and the locomotives in use were lightweight affairs, incapable of hauling heavy freight along grades. Most importantly, there was no standard gauge of track. Where two different lines met it often meant that passengers and freight had to be off-loaded from one train and reloaded onto the other, a time consuming, and therefore expensive, business. By 1880 railroads had become a very real threat. Steamboat operators responded with better service. Schedules were maintained, freight was handled with more care and passengers extended every courtesy. In spite of competition from railroads the tonnage carried on the river soared to pre-war levels and by 1880 steamboats were carrying more than one million tons annually (Douglas 1961: 89-91, 184-185; Johnson 1978: 111).

Much of that tonnage reflected the economic boom in the Upper Cumberland basin. Railroads had yet to conquer the rough terrain of the upper river valley and steamboats remained unchallenged here. They carried hardware, farm tools and other manufactured goods upriver. On the downriver runs packets might carry hogs, cattle, barreled pork, smoked side meat, molasses, eggs, hides and tobacco, but the big freight item was lumber. By the early 1870s the hardwood

lumber industry was booming. Between 1870 and 1880 hundreds of thousands of board feet of rough-sawed lumber were carried annually by steam packets. But steamboats were unable to pass beyond Burnside. The river above was the domain of the coal barge and the log raft. Logs in immense quantities were floated downstream in great log rafts, 200 feet long and 30 feet across. Coal, too, was being carried down the river, but on huge flatboat barges. Commerce of all sort, however, was determined by the water level. For months out of the year it was impossible to navigate the Upper Cumberland, there simply was not enough water in the channel. When the river rose during the winter and spring tides, and the water was running exceptionally well, log rafts and coal barges would try to catch the "tide" and ride it all the way to Nashville. But a mighty obstacle stood in the way of those coming downriver from the mouth of the Laurel River – Smith's Shoals (Annual Report of the Chief of Engineers 1882: 1845; McCague 1973: 184-187).

Smith's Shoals was actually a series of shoals, consisting of Shadowen Shoals, White Cliff Ripple, Long Shoal and Mill Shoal, which were located just above Burnside [before the Civil War known as Point Isabel]. These shoals formed the most serious obstacle to navigation between Cumberland Falls and the mouth of the Cumberland, an estimated distance of 591 miles. Smith's Shoals had an aggregate fall of fifty-five feet in eight miles and was considered the worst piece of water on the entire Cumberland. A good many of the rafts, barges and flatboats that tried to navigate the shoals never made it to the other side (Annual Report of the Chief of Engineers 1882: 1845; McCague 1973: 184-187).

In spite of the healthy packet trade and the booming coal and timber industries Congress appropriated only $150,000 between 1870 and 1880 for improving the river. But a small amount of that money was directed toward a survey of Smith's Shoals to determine how best to subdue this dangerous stretch of water. Following the survey, which took place in 1875, a plan of improvement was formed which involved " . . .smoothing and narrowing the channel, by excavating reefs and bowlders [sic], and building wing-dams at intervals, so as to facilitate the down-stream passage of coal-boats and rafts, the velocity of the current being too great to admit of up-stream navigation, without recourse to locks and dams." This course of action, open-channel work and the construction of wing dams, was adopted and work begun when river levels permitted (Annual Report of the Chief of Engineers 1882: 1845; Douglas 1961: 186).

The engineers continued to request appropriations to carry on improvements to the river, basing their arguments on the economic necessity of improving navigation:

> The entire valley of the Cumberland River will be largely benefited by the improvement of the river, as railroads cross the river at but few points, and as a rule are far distant from the immediate lands along the river to render transportation cheap. The coal of the upper river and the iron of the lower river depend almost entirely upon the river for a means of getting to market, and with the improvement of the river a corresponding improvement in the trade in these articles will follow. The lumber trade is increasing rapidly each year (Annual Report of the Chief of Engineers 1880: 1678).

Improvements continued to be made as appropriations allowed, all of them open-channel work. Open-channel work, as a method of improving navigation on the river, had several advantages. It was economical. It could be accomplished relatively quickly. It cleared the channel of the

worst of obstructions. But for all of its advantages it could not provide an adequate channel depth for year-round navigation, and for much of the year portions of the Cumberland were not navigable: "The Cumberland River is navigable for all of the above steamboats [all steamboats engaged in trade on the river] for six months of the year from Nashville to the mouth of the river; from six to eight months for boats drawing 3 feet or less; from nine to ten months from Nashville to the mouth for boats of about 20 inches draught. Distance 192 miles. Above Nashville the Cumberland is navigable to Point Burnside (crossing point of the Cincinnati Southern Railroad), a distance of 358 miles, for from four to six months for steamers of 3 feet draught or less, and from two to three months for larger boats" (Annual Report of the Chief of Engineers 1882: 1843). The same report also stated: "The method of improvement by locks and dams, which is the only one by which a low-water navigation can be secured above Nashville, or in fact below Nashville, excepting for small steamboats, has heretofore been considered too expensive to be undertaken, and the present plans [open-channel work] are designed to give additional depth at medium stages of the river, and to prolong the season of navigation" (Annual Report of the Chief of Engineers 1882: 1843; Johnson 143).

In spite of these statements engineers on the Cumberland were ready to embrace the installation of locks and dams. In 1878 a moveable dam had been constructed on the Ohio River at Davis Island, inaugurating a canalization project on the Ohio that would not be completed until 1928. The success of the dam at Davis Island spurred the engineers to request another survey of Smith's Shoals. On March 3, 1881 Congress authorized a survey of the Cumberland River at Smith's Shoals, near Burnside, Kentucky "to ascertain the practicality and cost of a canal, with locks and dams, from the head to the foot of said shoals" (Annual Report of the Chief of Engineers 1882:1862). Because a thorough survey of the shoals had been made in 1875 the survey of 1881 was limited to measurements needed to make cost estimates and to ascertain the practicality of the work (Annual Report of the Chief of Engineers 1882: 1862-1863; Johnson 1978: 143).

Basing his conclusions on data collected by Assistant Engineer W. C. Crozer, who conducted the survey, Maj. William R. King, the officer in charge of the improvement, concluded that "There is no doubt as to the practicability of building locks and dams so as to give a desired depth of water at all points on Smith's Shoals" (Annual Report of the Chief of Engineers 1882: 1863). He believed that two dams would be necessary to effect a usable improvement. One dam, to be located at the head of Mill Shoal, would be accompanied by four locks of sixteen feet lift, the second would be at or near Shadowen Shoals and would require three more locks (Annual Report of the Chief of Engineers 1882: 1862-1864).

Outlining the advantages of adopting this plan of improvement King stated that it would insure safe and reliable navigation for rafts and coal boats at all seasons of the year, it would allow steamboats to ascend, as well as descend, the river, and the improvements thus made would be permanent. The disadvantages to the plan were the cost, $875,000, and the time it would make to complete the work. With liberal appropriations he saw the work taking four years, while "at the rate such appropriations are usually made, a much longer time would elapse before the improvement would become available" (Annual Report of the Chief of Engineers 1882: 1864).

King believed that the present system of dams was adequate, and that if coal miners took full advantage of the boating tides they could ship as much coal as they could mine, safely and profitably. He also believed that for rafts and saw-logs, the present system was perhaps better than a system of locks and dams would be. Concerning steamboats he said " From the head of the Great Falls to the head of Smith's Shoals the Cumberland River falls 324 feet and is so badly obstructed by bowlders [sic] that it can never be made navigable for steamboats at any reasonable cost; it is not therefore probable that the improvement, even if completed as herein estimated for, would ever be extended to the Upper Cumberland." The essential parts of the open-channel work and wing dams, which had been authorized after the 1875, survey had only been completed shortly before June 30, 1882. Maj. King ultimately recommended that the system of dams presently in use be tried for at least one year longer (Annual Report of the Chief of Engineers 1882: 1862-1864).

Evidently not satisfied with action taken by the Federal government private interests formed the Cumberland River Improvement Company, which was chartered by the Commonwealth of Kentucky in 1882. The stated purpose of the company was to construct locks and dams on the Upper Cumberland, to aid the movement of barges carrying coal from the mines above Burnside. The company never got into active operation and its charter was eventually repealed. The formation of the company did, however, delay any action Congress might have taken regarding the canalization of Smith's Shoals. Congress would do nothing at the Shoals as long as such a corporation was in existence (Johnson 1978: 145).

Although no action was taken regarding Smith's Shoals Congress was evidently not convinced that the present system of open-channel improvements was, indeed, adequate above Nashville and in August 1882 ordered a survey of the Upper Cumberland "with a view to ascertaining the 'cost of placing locks and dams on the Cumberland River from Nashville, Tennessee, to the Cincinnati Southern Railroad in Kentucky' [Point Burnside]" (Annual Report of the Chief of Engineers 1883:1490). The survey was led by Assistant Engineer C. A. Turrill and was conducted between July 15 and November 1, 1883. A continuous line of levels was run from Point Burnside to Nashville, a distance of 328 miles. In addition, a transit line with cross-sections and soundings was run at the shoals and possible lock sites. In his report to Maj. King Assistant Engineer Turrill described the work performed:

> The survey party was made to consist of three divisions-the transit, level and sounding parties. The transit party made use of the chain and stadia rod, and ran a continuous magnetic meridian line from Burnside, Ky., the initial point, to Nashville. Sufficient topography was included in the notes to give approximately the height and slope of the banks and bluffs, the width of the channel and width of river bottoms, and the locations of tributaries, islands, bars, towns, landings and mills.
>
> The sounding party took channel soundings throughout the entire river surveyed, and also sounded through unused island chutes. Numerous cross-sections were taken by means of soundings in river, and pocket level to top of banks. These cross-sections were taken at points suitable for locks and dams, and the character of the bed of the river noted. Temporary gauges were kept near the camp each night and most of the day, to determine the oscillations of the river, of which a constant record was kept. These gauge-readings were checked at three different points on the river, where gauges were in charge of United States watchmen having care of Government property. Particular attention was paid by the sounding party toward

> obtaining the least depth in channel over shoals. These depths will show just what water is available for extreme low-water navigation at present.
>
> The level party ran a connected line of elevations all the way from Burnside to Nashville, taking the elevation of the surface water on shoals at points where a change of slope occurred, and a sufficient number in pools to determine accurately the profile of the water surface (Annual Report of the Chief of Engineers 1884: 1667-1668).

The resulting report concluded that the physical characteristics of the river were extremely favorable to the construction of locks and dams. The height of the banks, stable bedrock river bottom and readily available supply of building stone were all cited as contributing to the feasibility of the project. Twenty-three locks, with lifts varying from 6.5 to 11.8 feet at low water, were recommended for that part of the river from Nashville to the foot of Smith's Shoals. The report specified that the locks should have sidewalls of a height sufficient to permit boats to pass the locks until the water was high enough to allow them to pass over the dams. The suggested lock dimensions were given as sixty feet wide and two hundred fifty feet long, the locks to be constructed of solid masonry and the dams of stone and timber. The estimated cost was $3,202,922 (Annual Report of the Chief of Engineers 1884: 1667-1668).

Two years earlier, in 1882, Maj. William R. King, the officer in charge of the improvement, had recommended seven locks as necessary to canalize the Smith's Shoals portion of the river, that is, from the foot of the Shoals to Point Burnside. Twenty-three lock for the lower portion of the Upper Cumberland and seven for Smith's Shoals meant a total of thirty locks to canalize the navigable portion of the Upper Cumberland, from Nashville to Point Burnside, at an estimated total cost of $4,077,922. King believed that the improvements, if undertaken, should begin at Nashville and be extended up the river, in order that the improvements could be utilized as fast as completed. King was still not entirely convinced that canalization would be advantageous in all portions of the river and believed that jetties would suffice, at least in some areas. He further stated that the construction of dams would halt navigation entirely for indeterminate periods of time. Major King also pointed out that, once built, dams would hinder descending traffic, principally log-rafts and flatboats, and recommended that the channel be further deepened by regulation instead of implementing canalization. However, he said, if Congress was to undertake a canalization project the appropriation should be enough to complete at least three locks and dams above Nashville, approximately $400,000 (Annual Report of the Chief of Engineers 1882: 1864-1865; Annual Report of the Chief of Engineers 1884: 1667-1668).

Congress chose to ignore Maj. King's advice and to initiate a massive canalization project on the Upper Cumberland. Unfortunately, Congress also chose to ignore the Major's advice regarding the appropriation and did not appropriate sufficient funds for a canalization project. Maj. King was understandably livid when he learned that only $50,000 had been appropriated by an act approved July 5, 1884 for improving the Upper Cumberland and made his feelings known publicly: "Above Nashville only $50,000 have been appropriated for a system of locks and dams estimated to cost over $4,000,000, at which rate it would take eighty years to complete the work." Maj. King was not far from wrong in his estimates. In fact, only nine of the thirty locks and dams proposed were ever constructed, and it took forty years to complete even those (Annual Report of the Chief of Engineers 1884: 1664-1665; Johnson 1978: 144).

The following year Maj. King again asked for an appropriation of $400,000. He was still not convinced that the lock system was entirely desirable and, hedging his bets, stated "The amount available and the appropriation asked for ($400,000) can be profitably expended in operations above Nashville in building locks and dams and in such open- channel work as will be needed whether the lock system is carried out or not, the work to be carried on in a positive manner, so as to ascertain just how far wing and training dams can be used to advantage in place of the lock system." In spite of his request appropriations would continue to be inadequate through the life of the project (Annual Report of the Chief of Engineers 1885: 1763).

In 1886 Maj. William R. King left the command of operations on the Cumberland and Tennessee Rivers. His successor was Lieut. Col. John W. Barlow who took up station in Chattanooga, remaining there until 1888 when he became the first Nashville District Engineer. Barlow was a seasoned combat engineer who had served at the Battle of Bull Run, in the Peninsular Campaign, the Battle of Atlanta and the Battle of Nashville. After the Civil War he served as Gen. P. H. Sheridan's chief engineer in the far west and led the first exploration of the Yellowstone. He would later, in 1901, become Chief of Engineers, United States Army (Johnson 1978: 145-146).

While Congress moved ahead, albeit slowly, with plans to construct locks and dams on the Upper Cumberland the trade they were designed to assist was diminishing. The coal trade, once the exclusive domain of the river, was gradually being siphoned off by the railroads. The lumber trade was still active, and growing, but most lumber was floated down the river in huge log rafts. Many argued that the construction of locks and dams would actually impede the progress of the behemoth rafts, not assist them, and in that they were probably correct. Locks and dams would assist the steam packets carrying rough sawn lumber but those were rapidly diminishing as timber concerns adopted the cheaper method of floating whole logs to sawmills near Nashville. Steam packets carrying other goods were still active but every year saw a decrease in their numbers (Douglas 1961; 204, 226-227; Johnson 1978: 144-145).

Nonetheless plans to move ahead with the canalization project were being formed. An appropriation made August 5, 1886 was to be expended in building the lock nearest Nashville and in continuing open channel work, as necessary, under the existing plan. That year surveys were conducted to determine the best site near Lower Nashville Island for the proposed lock. An examination was made of the riverbed and the banks, and of the rock formations from Hartsville Ferry, eighty-seven miles above Nashville, to Clarksville, fifty-eight miles below Nashville, for rock suitable for the dimension stone for the proposed lock. In January 1887, a map of the proposed lock site and plans for the lock were drawn up by Lieut. Col. Barlow and Assistant Engineer Charles A. Locke. The proposed lock was to be 250 feet long between the miter-sills and 50 feet wide, and to have an extreme lift of 12 feet. The design for the first lock and dam on the Cumberland, Lock and Dam No. 1, to be constructed just below Nashville Harbor, was then submitted to the Chief of Engineers for approval (Annual Report of the Chief of Engineers 1887: 1760).

In March 1887 a board of engineer officers convened to examine Barlow and Locke's recommendations. The majority of the board agreed with the recommended dimensions for the lock and was unanimous regarding the location and lift of the proposed lock. In order that the work might be begun and carried on at the earliest day possible at the proposed site an

application was made to the legislature of the state of Tennessee for ". . . an act to give consent to the purchase by the United States of such lands as may be required for sites of locks and dams, etc., at or near the lower island at Nashville, and to grant cession of jurisdiction over said lands." The governor approved the act in March 22, 1887 (Annual Report of the Chief of Engineers 1887: 1760).

That same year, Lieut. Col. Barlow requested authorization to conduct an instrumental survey of the Cumberland River below Nashville: " . . . as Congress has already provided for a radical improvement of the river above Nashville by a system of locks and dams, beginning with a lock at the Lower Nashville island, it may reasonably be anticipated that the section below Nashville will ultimately form a part of the complete system of canalization, to the advantage of navigation and the general interests of the Lower Cumberland; the river forming the highway, and in many cases the only means of transit for persons and property, between the villages and towns scattered along its lower course. An instrumental survey of the river below Nashville, similar to that made in 1883 above Nashville, is very desirable, and should be made without delay . . ." (Annual Report of the Chief of Engineers 1887: 1759).

The Board of Engineers report, issued in the Annual Report of the Chief of Engineers for 1888, recommended that the lifts of all locks and dams on the Cumberland River be from ten to twelve feet, the exact height to be determined by the local engineer based on local conditions. The plans prepared by Barlow and Locke for Lock and Dam No. 1 called for a lift fixed at nine feet. Guidelines for the design of the guards stated that they should be ". . . such that the fall over the dam at the epoch of submergence of the lock-walls will not exceed 1 foot when the discharge of the river for that stage is at its maximum" (Annual Report of the Chief of Engineers 1890: 2144). Thus the design of the guards was dependent upon the discharge of the river, but in 1887 the discharge of the Cumberland at the site of proposed Lock and Dam No. 1 had not been measured (Annual Report of the Chief of Engineers 1890: 2144).

Although the design of the dam was still undecided the plans for the construction of the lock, which were somewhat different than those originally proposed, had been finalized and accepted. The lock was to be 52 feet wide with a lock chamber 280 feet long. It would have a lift of nine feet, with a depth of four feet of water on the lower and five feet of water on the upper miter sill. On April 24, 1888 Congress passed an act providing for the purchase or condemnation of the land necessary for the site of the lock, abutment and lockmaster's dwelling. As soon as title could be secured work would begin on the construction of the cofferdam, excavating the lock-pit and building the keeper's dwelling, which would be used as an office and storehouse during construction. As rock was excavated from the lock-pit, it would be stored to be eventually placed in the permanent dam. On September 19, 1888 a contract in the amount of $57,080 was entered into with Holmes & Wilk of Nashville for the construction of a part of the masonry of Lock No. 1 (Annual Report of the Chief of Engineers 1888: 1614-1615; Annual Report of the Chief of Engineers 1892: 1935).

In 1888 Lieut. Col. Barlow made the argument that the section of the river from Burnside to the Kentucky state line had claims for immediate improvement as great as those on that part of the river directly above Nashville. He went on to say that the facilities for carrying on the improvement were the equal, if not the superior, of those near Nashville and that stone was

readily available and other supplies could be easily procured via Cincinnati. He stated that if the pending river and harbor bill became law the monies appropriated could be ". . . profitably expended in completing Lock No. 1 at lower Nashville Island, and in procuring sites for and construction of Lock No. 2 near Beck's Ripples, about 14 miles above Lock No. 1. Also, if the plan herein recommended to carry on work in two sections – the upper one being in Kentucky – be approved to secure site and begin the upper lock of the series, about 4 miles below Burnside, Ky., near Waitsborough" (Annual Report of the Chief of Engineers 1888: 1616).

In August 1888, the survey of the Lower Cumberland River, which had been requested by Lieut. Col. Barlow in June 1887, was authorized by Congress. Over the next year a survey party was organized and was ready to begin by the end of June 1889. By the end of 1888, the seed of an idea had been put forth suggesting that improvements on the Lower Cumberland also be initiated, and that work on the Upper Cumberland begin at two widely separated locales, Nashville and Point Burnside.

Between 1887 and 1889 the discharge of the river was measured and the measurements used in creating standard formulas for the discharge over submerged weirs. These formulas revealed that ". . . there is no height of lock wall within reasonable limits that will secure the fall of 1 foot or less over the dam at the epoch when the lock passes out of submergence" (Annual Report of the Chief of Engineers 1890: 2144). In practical terms what this meant was that if a dam were constructed with a lift of nine feet it would cause a stoppage of steamboat navigation at the lock, its duration dependent upon the duration of particular stages of high water (Annual Report of the Chief of Engineers 1890: 2144).

The Board of Officers of the Corps of Engineers, constituted by Special Orders, No. 68, Headquarters Corps of Engineers, October 16, 1889, met November 14, 1889 in Nashville to consider the ramifications of the new findings. The report of the board stated: "In view of the uncertainties surrounding the subject and of the great importance of avoiding all embarrassment to commerce of so important a port as Nashville, the local engineer concluded after a careful study of the whole matter that the necessities of the case required, if possible, some form of dam that would give the required lift of 9 feet in low water, but could be lowered in high water so as to guarantee the safe passage over it of all river craft when the lock was submerged. In other words the top of the dam, or the whole of it, should be movable" (Annual Report of the Chief of Engineers 1890: 2145).

Six different types of movable dams had been previously constructed on the inland waterways, the Poirée dam, Chanoine system, Desfontaines system, the overhead system, the system of revolving gates and the American bear-trap. It was this last that the board recommended in 1890. The American bear-trap system consists of wide, flat leaves, one resting on top of the other when down, the upstream edge of the upper leaf and the downstream edge of the lower leaf being hinged to the foundation. This type of system was in use at Davis Island, on the Ohio River. The board recommended that detailed studies be undertaken at Davis Island to see if the bear-trap was a practical choice for Dam No. 1 (Annual Report of the Chief of Engineers 1891: 2271).

Barlow's long awaited survey of the Lower Cumberland finally began in July 1889. The purpose of the survey, which took in all of the lower river, from Nashville to the Ohio River, was to

determine the necessity, feasibility and benefits to be gained from constructing locks and dams on the lower river. The survey was under the direction of Charles A. Locke, Assistant Engineer of the Nashville District. In addition to Locke the survey party consisted of an engineer in charge of transit and plane table, two engineers in charge of levels, six rodmen, one cook and six laborers, who no doubt were charged with clearing brush and other obstacles to mapping as well as guiding the two house flatboats which served as office, living and sleeping quarters, cook-house and mess hall (Annual Report of the Chief of Engineers 1890: 2153).

High water necessitated a pause in the survey from July 30 to August 15 but work then resumed. The entire party was taken ill during the latter part of the survey, suffering from chills and fever, which was later diagnosed as malaria, but they somehow managed to reach Paducah on October 6, where they left the flatboats in charge of a watchman (Annual Report of the Chief of Engineers 1890: 2153; Johnson 1978: 149).

The results of the survey were encouraging. In his report based on Locke's findings, Nashville District Engineer Lieut. Col. John W. Barlow concluded that from the mouth of the river to Big Eddy, a distance of forty-three miles, conditions were such that no locks or dams were necessary. The fall in this section of the river averaged only 1.8 inches per mile and in general had a depth at low water of five feet or more. Five places were recommended for improvement in the form of dredging, rock excavation and the construction of one wing dam. The second section of the lower river, 144 ½ miles between Big Eddy and Lock No. 1, had a fall averaging 5.7 inches per mile. Barlow concluded that this portion of the river would benefit greatly from the construction of locks and dams; and that conditions were extremely favorable toward their construction, perhaps more so than on the Upper Cumberland. Borings indicated that the dams could be placed on solid rock, and that a sufficient length of dam could in all cases be constructed, avoiding the necessity of movable dams. Seven locks, more or less evenly distributed along this portion of the river, would give a lift at each site of less than ten feet. Locke recommended placing locks and dams at Reed's Reef, immediately below Harpeth Shoals; the second at Davis Ripple, ten miles further down river; the third eleven miles below Davis Ripple; the fourth at Yellow Creek; the fifth at Dover Shoals, the sixth at Little River and the last at Big Eddy Shoals. The dams were to be "of fixed character," the material to be timber cribs filled with stone. The locks were to be "first class masonry" and the report stated that sufficient stone of good quality was to be found at convenient points on the river. The cost of the seven proposed locks and dams was estimated to be $1,783,350 (Annual Report of the Chief of Engineers 1890: 2155-2161).

Construction Begins – Fall 1888

In the fall of 1888 canalization of the Cumberland finally began. The lands for the site of the lock and the lockkeeper's house at Lock No. 1 were purchased and conveyed to the United States; the lock to be located on the north bank and the abutment on the south bank of the river. In September 1888 a contract was entered into with Holmes and Wilk of Nashville for excavating the lock-pit and partial construction of the lock walls. As soon as river levels permitted work on the cofferdam and excavation of the lock pit began, but a prolonged high-water season permitted little active work. By June 1889 only 100 feet of the 800-foot cofferdam had been completed, 865 cubic yards of rock had been excavated from the lock-pit and a small quantity of stone had been quarried for the lock masonry. In November 1888 a contract was

entered into with Phillip Lewis Hedrick of Nashville to build the lockkeeper's house, which was to function as the engineer office and store-house during lock construction. The house was completed, and accepted, by the summer of 1889 (Annual Report of the Chief of Engineers 1889: 1841).

Special Order 191, enacted in August 1888, directed Lieut. Col. Barlow to move his office from Chattanooga to Nashville, thus creating the Nashville District, Corps of Engineers, and shifting attention from the nearly completed project at Muscle Shoals to improvements underway on the Cumberland. The years 1888 and 1889 saw a wave of public enthusiasm for improvements to the Cumberland River. Editorials in Nashville newspapers urged Congress to make larger appropriations for the locks and dams. Col. M. T. Bryan, one of Nashville's most enthusiastic rivermen, organized the Cumberland River Improvement Association in Nashville on November 20, 1889. The Association was formed with the sole purpose of inducing Congress to increase the appropriations to carry forward the canalization proposed for the Upper Cumberland. The Association was heartily behind the improvements underway on the Upper Cumberland but was dismayed by the small size of the appropriations made by Congress. Unless Congress could be induced to take more favorable action, they argued, several decades would elapse before the project was completed and the benefits to navigation realized. Improvements, it seemed, were definitely warranted. Although tonnage was down from 1880 levels, packets on the Cumberland River handled 875,000 tons of reported freight in 1889, a figure that excluded unreported items such as coal. Although members of the Association and others did not realize it such a figure would never be approached by the steam trade again (The Cumberland River Improvement Association 1892: 7-9; Douglas 1961: 221-223; Johnson 1978: 147).

By the end of June 1889, the site of Lock and Dam No. 2 and the lockkeeper's house, had been approved by the chief of Engineers and negotiations were in progress for the purchase of the land. A line of levels had been run from the site of Lock No. 2 to Jones Island and sites were being examined in that vicinity for the placement of Lock No. 3. To expedite the purchase of lands for the locks, abutments and support buildings an application was made to the Tennessee legislature ". . . for an act to give consent to the purchase by the United States of such land for sites of locks, dams, lock-keepers' houses, etc., as may be required in the improvement of the Cumberland River by the United States and to grant cession of the jurisdiction over such lands." The act was approved by the governor of Tennessee on January 26, 1889 (Annual Report of the Chief of Engineers 1889: 1842).

Lock No. 1 progressed slowly. Construction activities were sandwiched between seasonal slow-downs and work stoppages necessitated by changing water levels in the capricious Cumberland. The contractors, Holmes & Wilk, were unable to work between the end of October 1890 and sometime in May 1891 because of high water. In fact, high water in the previous two seasons had permitted only sixty-nine days of work on the lock. Because of this sporadic, but unavoidable, work schedule only 1,699 cubic yards of earth and 10,855 cubic yards of rock had been removed from the lock pit by the close of the fiscal year 1891. At the quarry site 842 ½ cubic yards of rock to be used for the masonry at Lock No. 1 had been quarried, cut and accepted by the United States (Annual Report of the Chief of Engineers 1891: 2271).

The contract with Holmes & Wilk had been amended in 1891 because it was found that masonry would have to be substituted for the natural rock called for in the original plans for the land wall, substantially increasing the cost. The new date of completion was set for December 31, 1892. In October, 1890 Henry Holmes of Nashville was contracted for the partial construction and completion of the masonry of Lock 1. The recommendation of the bear-trap system for Dam No. 1 was overturned in 1891 and the decision was made to construct a fixed dam, following the plans originally outlined in the report submitted by Barlow and Locke in 1887. When the decision was made to construct a fixed dam, rather than a movable dam, it became necessary to increase the height of the lock walls at Lock No. 1 to provide for a depth of water of four feet on the lower miter sill and six and one-half feet on the upper miter sill. This change necessitated additional masonry and the contract with Henry Holmes was modified to accommodate the changes, increasing his remuneration from the $35,490.50 originally agreed upon to $60,741.50. The job as now described was to be completed by December 31, 1893. On May 30, 1891, about six months after the design for Dam No. 1 had been finalized, Holmes & Wilk of Nashville were contracted to construct the abutment of the dam and by the end of June 485 cubic yards of earth had been excavated (Annual Report of the Chief of Engineers 1892: 1934).

Most, or many, of the locks would be constructed before construction began on any of the dams, for, as the Chief of Engineers stated: “A lock and dam constitute an obstruction to navigation which is only justifiable when their aid to navigation counterbalances their injury. The locks alone are no obstruction. The dams should not be built until they are required as an aid to navigation, which will not be until more than a half dozen locks are built. By this plan the river will be unobstructed with dams until their construction will be an immediate benefit, and for these years the improvement is saved the expense of maintaining lockkeepers and the wear and tear on lock machinery and the dams. It is proposed to prosecute work simultaneously on as many locks as the available funds will permit” (Annual Report of the Chief of Engineers 1892: 1937).

During this time progress had also been made on Lock and Dam No. 2, to be located about 12 miles upriver from Nashville. In October 1889 the sites of the lock and the lockkeeper’s house had been purchased. A contract was entered into with Rich & Holmes of Nashville, Tennessee on February 24, 1891 to construct all of the masonry of the lock, the cofferdam and to complete excavation of the lock pit. Their compensation was set at $163,550 with a completion date of August 24, 1892. In May 1891 the site of the abutment of Dam No. 2 had been condemned “to the use of the United States.” By June 30,1891 3,000 cubic yards of earth had been excavated at the lock site (Annual Report of the Chief of Engineers 1891: 2272).

In addition to major construction work on the Upper Cumberland work of a more minor character connected with canal construction was also carried out. A small boat was fitted with derrick, drill and pump to be employed in examinations pertaining to lock sites and so on. This craft was used to survey the upper approach to Lock 1, make test borings at Lock 2, to examine land near Buttermilk Shoals for the site of Lock 3 and to run a check line of levels from Lock No. 1 to Locks Nos. 2 and 3, and to Gallatin Island to aid in the selection of the site for Lock No. 4 (Annual Report of the Chief of Engineers 1892: 1936).

Although the canalization project was making progress appropriations from Congress continued to be small, forcing the contracts for the necessary work to be let piece-meal. In November 1891 the Cumberland River Improvement Association held their second meeting in Nashville. The Association stated: "That the Government's work of locking and damming the river is just the right kind of improvement, and will give an impetus and afford an outlet to these varied resources [of the Cumberland Valley] will not be questioned" (Cumberland River Improvement Association 1892: 20). As before, however, the Association urged Congress to appropriate sufficient funding "The work of improvement is now just well under way and its early and successful completion rests with Congress . . . Congress will meet shortly and will, at least should, pass a river and harbor bill, and it is a matter of the first importance that is contain a liberal appropriation for the Cumberland River" (Cumberland River Improvement Association 1892: 20, 22). Unfortunately, liberal appropriations were not forthcoming (Cumberland River Improvement Association 1892: 20, 22).

Although the members of the Association were enthusiastic about improvements to the Cumberland there seemed to be little popular support for the program. Land owners along the river frequently opposed the project, not wanting fertile bottom lands inundated. Even some steamboat captains said the improvements were unnecessary. Railroad interests, of course, were vehemently against such improvement, saying that the cost could not justify the benefits, which they argued were strictly local (Douglas 1961: 261-262).

As the battle for appropriations continued work was proceeding satisfactorily at Lock No. 1, but problems had developed at the site of Lock No. 2. The contract had specified that the excavations for the lock pit would be carried to seven feet, and in some places to ten feet, "below the low-water pool No. 1" and that the foundation "shall be excavated to solid rock." Borings made before construction started had shown solid rock at or above this level, but actual excavation had revealed that solid rock was not to be found consistently throughout the site of the lock pit anywhere close to the depths specified in the contract. It was imperative that the masonry be built on a foundation of solid rock. To reach a solid rock foundation meant considerably more work than specified in the original contract. To further complicate matters, one of the principles of the original contract had died since the contract was originated and his estate was unwilling to modify the original contract. It was decided to terminate the contract and decide on suitable compensation for work already completed. In the meantime there was still the problem of the irregular foundation at the lock site. The ultimate decision was shelved pending a more thorough examination of the present site, which had to wait until low water. Alternate sites would also be examined and the decision made to continue at the present site or begin anew at a different location (Annual Report of the Chief of Engineers 1892: 1939).

Congress authorized the canalization of the Lower Cumberland in 1892 and appropriated funds to acquire land and begin construction on the first lock and dam on the Lower Cumberland, Lock and Dam A, to be constructed at Harpeth Shoals. Later that same year preliminary work began on selecting a site for Lock and Dam A. Between September 1892 and April 1893 a survey was conducted and the map completed in June. A site about two and one-half miles below the mouth of the Harpeth River was recommended and submitted to the Chief of Engineers by Lieut. Col. Henry M. Robert, who had succeeded Lieut. Col. Barlow as District Engineer in October 1891.

The site was approved on June 12 and procedures set in motion to secure title to the property (Annual Report of the Chief of Engineers 1893: 2392; Johnson 1978: 149).

Although it may seem odd that the canalization project was begun in the middle of the Cumberland, rather than at either end, there were sound reasons for the decision. Lock and Dam No. 1 created a pool for Nashville, the busiest harbor on the river, while Lock and Dam A inundated Harpeth Shoals, removing it as a barrier to navigation. The river below Harpeth Shoals presented fewer navigational problems, being deeper much of the year. Of course, one overriding factor was the decision of Congress to begin the canalization of the Cumberland River with the upper river, and with the lock and dam closest to Nashville. When canalization of the lower river was authorized several years later it was most logical to begin at Harpeth Shoals (Johnson 1978: 150).

By the end of June 1893 the abutment for Dam No. 1 had been finished. Three thousand forty cubic yards of earth and fourteen cubic yards of rock had been removed. In its place 697.4 cubic yards of masonry had been laid. Work on Lock No. 1 was proceeding more or less on schedule. By the close of the fiscal year 1,155 cubic yards of earth and 697 cubic yards of rock had been removed and 2,487 cubic yards of masonry had been laid. While Lock and Dam No. 1 was progressing construction activities at Lock No. 2 remained at a standstill. Test borings still remained to be made at the site, and surveys to locate alternate sites were not yet complete (Annual Report of the Chief of Engineers 1893: 2398).

Between June 1892 and June 1893 surveys had been completed for Locks and Dams Nos. 3 and 4 and site recommendations had been submitted to, and approved by, the Chief of Engineers. Lock and Dam No. 3 was to be constructed at Buttermilk Shoals, twenty-six miles above Nashville. Lock and Dam No. 4 would be built forty-five miles above Nashville, immediately above the mouth of Station Camp Creek at Bandy Shoals. By June 30, 1893 a little over four acres had been purchased for the abutment of Dam No. 3 and proceedings in condemnation has been instituted to acquire land for the sites of Locks Nos. 3 and 4 and the abutment for Dam No. 3. Lumber for the construction of the cofferdams, barges, a hoisting engine, rails for tramways, temporary buildings, vitrified brick (to be used in lock construction) and other materials had been moved to the sites of Locks Nos. 3 and 4 so that construction could begin the moment title to the land was granted to the United States. On June 20, 1893 advertisements were placed inviting proposals for supplying 7,912 cubic yards of cut stone for the building of the locks. The remainder of the stone necessary would come from several sources, including that which remained from unfinished Lock No. 2, and other currently "on hand." The backing stone would come from Chadwell's quarry, which was controlled by the United States (Annual Report of the Chief of Engineers 1893: 2398-2399).

The bids for stone to build Lock No. 4 were opened July 11, 1893 but none were considered acceptable. Shortly thereafter, the decision was made to build the lock entirely by hired labor; that is, the government would act as its own contractor. The engineer in charge would hire and supervise the labor force, oversee the work and procure the necessary materials. The work force was paid by the month or the day, depending on their positions. When the canalization project began in 1888 Lieut. Col. John Barlow, basing his experience on the canalization project on the Tennessee, had predicted that the contract system would not prove satisfactory on the

Cumberland. He was to be proved correct time and again. Both the contract system and the hired labor system would be used throughout the project and the contract system proved unsatisfactory not only to the government but to the contractors as well, who often lost money (History of the Construction of Lock 4, 1893- 94-95: 1; Johnson 1978: 153).

By the close of June 1894 a considerable amount of progress had been made on the Upper Cumberland canalization project. The survey of the river between Burnside and the mouth of the Rockcastle River was nearly complete. The masonry of Lock No. 1 had been completed. A new site had been selected for Lock and Dam No. 2 and excavation and construction had begun in late April. Considerable progress had been made at both Locks Nos. 3 and 4 and the lock chambers at both were nearly complete. A site had been selected for Locks Nos. 5 and 6 and acquisition of the property was proceeding. Suitable sites for Lock No. 7 were in the process of being examined so that a final recommendation might be made. Less progress was made on the Smith Shoals leg of the project. The sites for Lock and Dams Nos. 1-5 had been selected and maps prepared. The site for Lock No. 6 had not yet been selected but survey for a suitable site was to be resumed in July.

Survey work for the seven locks proposed for the Smith Shoals system of lockage had commenced at the end of July 1892. The survey team was charged with examining the river from Burnside to the mouth of the Rockcastle River. Ten months later detailed examinations of the proposed sites of the first two locks in the series had been made. By June 1894 examinations had been made of the sites for the next three locks, a total of five in all having been surveyed and the site for the sixth lock was soon to be recommended. Originally seven locks, providing for a six-foot navigation channel, had been approved for the project. But the survey had determined that six locks, each having a higher lift than originally specified, would provide the necessary six-foot depth and recommendations had been made to modify the specifications for the project (Annual Report of the Chief of Engineers 1893: 2399-2400).

The masonry for Lock No. 1 was completed by the summer of 1894 and work was begun on a survey of the lock site and its approaches. A base line was established and the task of making soundings was begun in the lower approach to the lock. The contract for Lock No. 2 had been terminated August 9, 1892 after excavation revealed that the suitable bedrock foundation, necessary for the lock masonry, was not to be found at a consistent depth at the current lock site. While test borings and soundings were made at the current lock site to determine the advisability of continuing construction, surveys were made of several alternate sites. A report submitted to the Chief of Engineers in February 1894 recommended that the old sites for Lock and Dam No. 2 be abandoned. A new site, about one and one-half miles below the old site, was approved in March 1894 and the land for the lock and right-of-way was purchased shortly afterward. Construction at the new site began April 25 and by the end of June fifty cubic yards of loose rock and 8,000 cubic yards of sand and gravel had been removed to make way for the cofferdam foundation. One hundred ninety-nine linear feet of the cofferdam had been completed, all of the usual temporary buildings had been erected and an incline was begun to be used in unloading lumber and other supplies and transporting them to the top of the bank (Annual Report of the Chief of Engineers 1894: 1812; Construction of Lock No. 2, to March 30, 1895:1).

Construction at Lock No. 3 began on September 7, 1893. By the end of the month the temporary offices, quarters for both white and black laborers, a blacksmith shop for black laborers and a water closet were complete. One week after construction began on the temporary buildings men were set to work clearing the lock site, a process that lasted the remainder of the year. While the lock site was being cleared the cofferdam, similar to that at Lock 4, was constructed. Gravel excavation for the cofferdam was accomplished with drag scrapers, drawn by a team on the bank, with a rope attached through a snatch block. The cofferdam was completed by the end of December and excavation in the lock pit began in October. Over 1,200 cubic yards of material was excavated before work was suspended for the season December 23 because of high water. Work was able to resume in March and a receiving pier and a trestle for the steam traveler were built. By May 1, 1894 the lock pit had been pumped out and excavation was able to resume. Almost 6,000 cubic yards of rock, earth and gravel were excavated from the lock site and placed in the cofferdam. By July 1 all rock excavation in the lock pit was complete and the masonry work had commenced. Almost one-third of the stone necessary for the lock masonry had been purchased and stored and was ready to be placed in the lock walls (Annual Report of the Chief of Engineers 1894: 1812-1813; Ellison 1895: 6).

The quarry for Lock No. 4, located directly across the river from the lock, was opened in August 1893. It would supply filling stone for the cofferdam and dimension stone for the lock wall masonry. Title to the land on the lock site of Lock No. 4 was acquired September 1, 1893. Work began at once on clearing the site of trees, building quarters for the men and erecting the cofferdam. The cofferdam was finished forty days after construction began. It was built of eight by eight inch pine in three divisions. "The outer [division] was filled with broken stone and the center and inner ones filled with earth well puddled with rammers" (History of the Construction of Lock 4,1893-94-95: 2). The finished cofferdam was 500 feet long, twenty feet high and twenty-four feet wide. When finished the top was covered with broken stone to prevent washing. Immediately after the cofferdam was finished excavation began, the stone being hauled by wagons to the top of the bank" (History of the Construction of Lock 4,1893-94-95: 2-3).

As at all of the construction sites, the temporary offices, quarters and other buildings were constructed on site. "The quarters furnished were of a temporary nature, but were substantial and comfortable; the buildings on lock side of river were, Mechanics quarters and office, Commissary, Blacksmith Shop, colored laborers' quarters, and white laborer's quarters, with kitchen and dining rooms for white and colored laborers attached, all arranged in line in order given, beginning at upper end of reservation and running parallel to river near the lower end of grounds, these buildings on account of land being sometimes subject to overflow, were erected on timbers that raised them 8 feet above the ground, the lower part of Commissary building was latticed up and used for tool house" (History of the Construction of Lock 4,1893-94-95: 3-4). On the opposite side of the river, near the dimension quarry, were an office, black laborers' quarters and a blacksmith shop. All buildings were constructed along similar lines, being boxed up of one-inch pine lumber. Before the end of the summer the site had been fenced and a road opened to connect the lock site with the Gallatin Pike. A trestle 380 feet long had been constructed for moving the steam traveler and one 230 feet long for the tram track. Almost one-half mile of tramway connected the quarry with the river (Annual Report of the Chief of Engineers 1894: 1812-1813; History of the Construction of Lock 4,1893-94-95: 2-4).

The selection of a site for Lock and Dam No. 5 had been hampered by bad foundations at several of the proposed sites, but in early January 1894 a suitable site was located and approved. The purchase of land for the site of the lock and dam and the necessary right-of-way was authorized in March. Of the 8.8 acres necessary for the lock and the right of way 7.3 acres were purchased for the sum of $900 soon after authorization was received. The purchase of the remaining 1.5 acres had become stalled by a defect in the chain of title but was expected to be resolved with little delay. The purchase of the site for the abutment for the dam, including the low-water sandbar known as Chambers Island, had been speedily concluded. The 11.2 acres had been acquired for $510 on May 22, 1894 and construction activities began immediately. By the end of June temporary buildings for quarters and storage had been moved to the lock site and construction materials for the cofferdam procured. The crib-work for the cofferdam, averaging five feet high and stretching from bank to bank, had been completed and was two-thirds filled with 1,164 cubic yards of sand and gravel (Annual Report of the Chief of Engineers 1894: 1813-1814).

The site for Lock and Dam No. 6 had been approved February 28, 1894 and negotiations were underway for the purchase of the property. The examination of possible sites for Lock and Dam No. 7 were begun in May and no decision had been reached by the close of the fiscal year (Annual Report of the Chief of Engineers 1894: 1814).

Work on the Lower Cumberland was not progressing nearly as rapidly as that on the upper river. The title for the land needed for Lock A, twelve acres, had been acquired and the title to the site of the abutment of the dam, 3.9 acres, was pending. But no further work was possible – the funds for the project were exhausted. The Chief of Engineers Report for 1894 stated: "Therefore, as soon as the necessary funds are made available, the construction of lock and dam A can be begun and executed to completion, and the most formidable obstruction to navigation of the Lower Cumberland – Harpeth Shoals – thus overcome" (Annual Report of the Chief of Engineers 1894: 1807).

During the next twelve months some progress was made on Lock and Dam A. The land for the abutment for Dam A was acquired and construction began on the lock site. A work force of thirty men arrived June 17, 1895 to begin construction of the temporary buildings. By the end of July, a commissary/tool house, mechanics' office and quarters, white laborer's quarters, dining room and kitchen, black laborers' quarters, blacksmith shop, magazine for powder and dynamite, and a magazine for oil had been constructed.

Dredging began on July 23, work having been delayed because the dredge boat had not arrived, and when it did was in need of repair. As gravel from the cofferdam foundation was excavated it was placed where it would be useful in filling the cribs of the cofferdam. A great many large boulders were encountered, some over one cubic yard in size. "This of course made the work slower and was very hard on the boat and machinery. It was not an unusual thing for the men to have to dive down and fasten a chain around some of these large boulders, so that they could be pulled up" (Report on Construction of Houses and Cofferdam at Lock "A" 1895: 4). The construction of the cofferdam, and the method of placing it in the river, was similar to that used at all of the locks on the Cumberland. A number of cribs, or pens, each eight by twenty feet,

were constructed from eight by eight inch pine timbers held together with twenty inch long, 5/8 inch drift bolts. The cribs were placed in the river in two rows, eight feet apart.

> The cribs were built on the gravel piles that had been worked to the water's level. They were built high enough to be above water after being floated in place, averaging about 9 ft. The water was never less than 6 ft. in depth, so the men were compelled to do a great deal of diving and swimming in setting the cribs in place. The cribs rested on the bare rock bottom the dredge having done its work well. After a sufficient number of cribs had been set, courses of timber were built upon them, bonding over the crib joints. Any small irregularity in the level of the tops of the cribs was adjusted by notching down and never by blocking up. This leveling was all done on the first course of timbers above the cribs (Report on Construction of Houses and Cofferdam at Lock "A" 1985: 5).

Once in place the cribs were filled, the two outer compartments with gravel and the inner compartment with puddled earth. Once completed, the water was pumped out of the cofferdam and excavation began. Most of the gravel had been removed by the dredge, but some still had to be removed by hand. A wagon road was extended from the bank to the pit and twelve wagons and teams and about thirty men were kept busy. Tramways were constructed, one for hauling timber for the cofferdam and other preparatory work, including preparing the foundation for the lock walls, was completed, as far as funds permitted, before the close of 1895. No new funding had been forthcoming and work was restricted to what could be carried out with the very limited monies on hand. Once again the Chief of Engineers stated " . . . the work of lock construction beyond that above cited is impracticable until a new appropriation is made available for expenditure" (Annual Report of the Chief of Engineers 1895: 2253; Report on Construction of Houses and Cofferdam at Lock "A" 1895).

Figure 5: Rock excavation within a cofferdam at Lock D, 1917, note mules and wagons.

Work on the Upper Cumberland continued unabated at most sites during the latter part of 1894 and the first part of 1895. Lock No. 1 was complete and no further work was done at the site. The lock masonry and that of the dam abutment at Lock and Dam No. 1 had been completed the previous year. In fact, less than $120.00 was expended during the entire fiscal year, and that was for "watching and taking care of lockkeepers' house and engineer property" at the site (Annual Report of the Chief of Engineers 1895: 2257).

Construction at Locks Nos. 2, 3, 4 and 5 progressed in an orderly fashion, no problems seemingly occurring on any of the sites. The abutment site had been acquired for Dam No. 2 in the autumn of 1894. At the lock site the cofferdam had been completed, as had the excavation of

the lock-pit. The rock at the bottom of the lock pit was badly seared by seams about two feet deep. These were filled with concrete to form a fairly uniform surface. Two crevices containing water will filled with Portland cement concrete, the water forced to two points where it was discharged through a pipe, it not being thought prudent to exclude it altogether. A portion of the masonry for the river wall, 823.1 cubic yards, had been laid and 475 cubic yards of riprap had been placed as protection for the cofferdam. A great deal of miscellaneous work was also reported as having been accomplished – stacking brick, grading bank, building a landing pier, constructing a tramway, erecting derricks and placing machinery in position for operating a steam traveler (Annual Report of the Chief of Engineers 1895: 2257; Construction of Lock No. 2 to November 30, 1895: 5-7).

The construction history of Lock No. 2 gives a detailed description of the procedures used in building the masonry lock walls. Stone for the masonry walls was transported from the unloading derrick on the bank to the lock pit in cars on a tram track. "Seven derricks were erected in the center of the lock and were erected in the center line of the lock and so placed as to command all the space to be laid except a part of each wing wall which was put in with pony derricks worked by hand." Double cylinder, double drum hoisting engines were placed between the river wall and the cofferdam and boilers for supplying steam were placed on the cofferdam. A pipe was laid along the whole length of the cofferdam with valves every sixty feet for hose connections. The water, supplied by a pump, was kept under fifty pounds of pressure at all times and was used for washing stone and mixing mortar. The mortar beds were at the head of the lock and between the river wall and cofferdam. "Mortar was taken to the working places over runs across the chamber and on the lock walls, and this method was found to be satisfactory and economical." Pointed face stone was used on the face of the walls in the chamber. Squared faced rubble was used on the back of the river wall and on the end of both walls. All other portions of the wall were laid with backing. All exposed faces and all of the wall opposite the hollow quoins were laid in Portland cement mortar. Alsen brand Portland Cement was used and found satisfactory in quality. The rest of the walls were laid in Louisville cement mortar. Problems had been encountered with Louisville cement at Lock 4, problems they were determined to avoid at Lock 2. The construction history states: "The Louisville cement was furnished by J. B. Speed & Co. of Louisville, Ky. and was all tested prior to shipment, none being shipped unless complying fully with the specifications; a knowledge of the careless methods of manufacturers of Louisville cement makes the thorough testing of it essential"

Figure 6: Similar pumping equipment used at Lock D in 1917.

(Construction of Lock No. 2 to November 30, 1895; History of Construction of Lock 4 1895: 13).

The masonry of the lock walls was nearly complete at Lock No. 3 by mid-summer 1895, only a small amount of coping needed to be laid to complete the work. Excavation of the lock pit continued, with over 2,248 cubic yards of solid rock, loose stone and earth being removed from the lock pit between June 1894 and June 1895. Over 7,500 cubic yards of concrete was laid in the foundation of the lock and filling culverts and a tremendous amount of sand, gravel and earth was moved at the site. Stone was quarried for paving and riprapping, slopes were paved, gravel was spread on the paving, fill was placed behind the lock walls and the 10,000 linear feet of the lock walls were pointed. In mid-September 1894 the work of removing the cofferdam was begun and the timbers shipped to Lock A for re-use. The work force began taking out derricks, disassembling the traveler frame and removing machinery at the end of November, a task which was competed in February (Annual Report of the Chief of Engineers 1895: 2257-2258; Ellison 1895).

Figure 7: Construction work at Lock 1 in 1891.

At Lock No. 4 over 97,000 bricks were laid for the lock wall foundations and filling culverts during the summer of 1894. Of necessity the bricks used were impervious to water, making them difficult to lay. Because they would not absorb any water from the mortar they were prone to "crawl" and it was impossible to lay more than two courses at a time, allowing those courses to set before building upon them. Once the foundation was prepared work began on the masonry of the lock walls. The first stone set was Sill Quoin on the lower end of the river wall on June 23. The walls were completed on November 30. By April 1895 the cofferdam had been removed and excavation of the lock pit begun, 1,900 cubic yards of material being removed during the fiscal year. Stone was quarried and cut for masonry. As at Lock No. 3, miscellaneous work included pointing the lock walls, grading the slope of the bank, clearing the abutment site and repairing and moving machinery (Annual Report of the Chief of Engineers 1895: 2258; History of Construction of Lock 4 1895).

The cofferdam at Lock No. 5 was completed in August 1894. The final one and one-half acres needed for the lock site had been acquired and the title transferred to the United States in May 1895. Excavation of the lock-pit was begun and construction of the dry wall commenced. Portions of the site were cleared, riprap was installed, and the bank and top of the cofferdam were paved, in addition to other miscellaneous work such as concreting crevices in the lock wall and setting up pumping machinery (Annual Report of the Chief of Engineers 1895: 2258).

The sites for the lock and abutment of the dam at Lock and Dam No. 6 had been approved and over half, 4.21 of a total of 6.76 acres, had been purchased, although title to a small portion had not yet been conveyed. The remainder of the property was condemned and awaiting final decree. No work was done at the lock site. The sites for Lock and Dams Nos. 7, 8, 21 and 22 had been approved and efforts were under way to acquire the land by voluntary purchase at the close of fiscal year 1895 (Annual Report of the Chief of Engineers 1895: 2259).

At the close of the following fiscal year, 1896, little had been accomplished at Lock and Dam A. The project was still stalled because funds had not been appropriated in sufficient quantity to proceed with construction. Once again in his annual report the Chief of Engineers urged that funds be made available: "The Harpeth Shoals form the most formidable obstruction to the navigation of the Lower Cumberland, and to overcome this obstacle the existing project has in view that Lock and Dam A be begun and pressed to completion as soon as possible . . . The appropriation of June 30, 1896 [$80,000] will allow the masonry to be begun, but not completed" (Annual Report of the Chief of Engineers 1896: 1908). With little money at his disposal the district engineer had done what he could. The site had been cleared, the temporary buildings finished and a well dug for the use of employees. The cofferdam, 700 feet long, had been completed October 1895. Riprap had been placed at the junction of the dam and bank and all of the excavation for the foundation of the lock, which could be done prior to the laying of masonry, had been completed (Annual Report of the Chief of Engineers 1896: 1909-1910).

On the Upper Cumberland excavation of the lock-pit and construction activities continued at Locks Nos. 2 through 5, Lock No. 1 having been completed in 1894. At Lock No. 2 excavation of the lock pit continued, 7,300 cubic yards of earth being removed since the previous July. Over 5,000 cubic yards of masonry was laid on the lock walls and 300 cubic yards of concrete was laid for the foundation of the lock chamber. Excavation was begun on the foundation for the wing walls and 134,059 bricks were placed in culverts. The rapid fall of the river at flood stage caused slides on the banks, they were simply re-sloped and work continued. Much work of a miscellaneous nature took place. Stone was hauled from the quarry at the old Lock 2 site, the right of way to the lock site was graded and paved, and the temporary buildings were repaired and whitewashed. Boats, stone-cars and water tanks were repaired and the government lands were fenced. "Six thousand three hundred and thirty and forty-one one-hundredths" cubic yards of stone for the masonry of Lock No. 2 was delivered on barges after being purchased under contract for the sum of $39, 286.67. The prices per cubic yard of the stone delivered was based on its classification: hollow quoins ($21.00), sill ($15.50), special stones and coping ($13.50), pointed face ($10.00), squared faced rubble ($4.50) and backing ($3.00) (Annual Report of the Chief of Engineers 1896: 1913).

At Lock No. 3 active operations were suspended on August 15, 1894. By that date the lock masonry had been laid and pointed, paving laid behind the lock wall, a retaining wall built behind the lock and the cofferdam removed. The excavation of the lower approach was completed and concrete was laid over the upper culverts. In what may have been one of the last tasks at the site stones were placed to mark the boundary of the United States lands. Lock No. 4 was almost as far along. The masonry had been completed in November 1894 and since that time only miscellaneous work had been done. The cofferdam had been removed, the banks cleared of

logs and drift and graded in preparation for riprapping or sodding. As always, repairs were made to boats, machinery and equipment (Annual Report of the Chief of Engineers 1896: 1913).

Locks Nos. 5, 6, 7, 8, 21, and 22 saw slow progress. At Lock No. 5 almost 900 cubic yards of stone was delivered for the masonry of the lock walls but no other activity was recorded. The lands had been acquired for Lock No. 6 but construction had not yet begun. The sites for Lock Nos. 21 and 22 had been approved and purchase authorized. The site of the abutment of Dam No. 7 had been purchased and the title approved. Condemnation proceedings had been instituted to acquire the remaining lands at Locks 7, 21 and 22 (Annual Report of the Chief of Engineers 1896: 1913-1914).

The Chief of Engineers, in the Annual Report issued in July 1898, was still recommending that Lock and Dam A be finished as soon as possible. The appropriation made in August 1896 had not been enough to accomplish much. In fact, the funds available did not justify beginning the masonry work on the lock since so little could be done with the monies on hand. Instead, the funds were used to build the abutment of the dam. At the lock site work was of a miscellaneous nature, mostly connected with obtaining stone for the lock masonry: "These funds were applied to stripping quarry, quarrying, and cutting stone for masonry of lock, moving stone from quarry to lock site and scabbling stone for backing. A large amount of miscellaneous work was necessarily done, consisting principally of surfacing and laying tram track, repairing turntables, tram cars and machinery; making scale cards and tram-car brakes, placing steam derricks and motive power for same in position . . . " (Annual Report of the Chief of Engineers 1898: 1877).

In spite of the money problems quite a bit seems to have been accomplished at Lock and Dam A. Temporary buildings were erected for employees and as storehouses, a cofferdam 700 feet long was built and excavation of the lock chamber was begun. The site, right-of-way and bank approaches to the lock were cleared, a landing pier completed and a tramway and gravity incline for moving stone from the quarry were built as described below. It proved to be necessary to move the buildings housing employees, the site initially chosen proving to be too low and, it was thought, unhealthy. To accommodate the move 13.55 acres abutting the lock site was purchased and suitable buildings erected (Annual Report of the Chief of Engineers 1898: 1876-1877).

Stone at Lock A, and several other sites, was moved from the quarry to the cutting yard by means of a gravity incline and tramway. The incline at Lock A, as described by Assistant Engineer John Simpson Walker, was typical of those used at other sites during the canalization project:

> The stone is cut under three derricks, and the cut stone is piled under the traveler, being assorted so that no extra handling will be required when it is taken out to be laid in the wall. Communication was had between the quarry and the stone yard by means of a tram track (3-foot gauge) from the traveler to the foot of the bluff, thence by a double-track gravity incline plane, 430 feet long and rising 130 feet, thence by a tram track (3-foot gauge) 1,000 feet long to the quarry. The gravity incline plane consists of two tracks, each of 5-foot gauge, with a cradle car on each track. The cradle cars are connected to a horizontal drum by means of seven-eighths inch steel wire hoisting rope. The drum revolves on its own horizontal axle, and the two ropes, attached respectively, to the cradles containing the empty and loaded cars, coil and uncoil on it alternately. The drum is made of a 5-inch round steel axle, two-brake pulleys-one at each end-

and a flat pulley midway between them. The pulleys are lagged with 4-inch by 6-inch oak; the diameter of the drum is 4eet, the brake pulleys are 5 feet in diameter on brake circles. A band brake, lined with sugar maple, placed at each end, enables the operator to have complete control over the cradle at all times. So far there has been no trouble with the incline; it has worked smoothly and satisfactorily (Annual Report of the Chief of Engineers 1898: 1885).

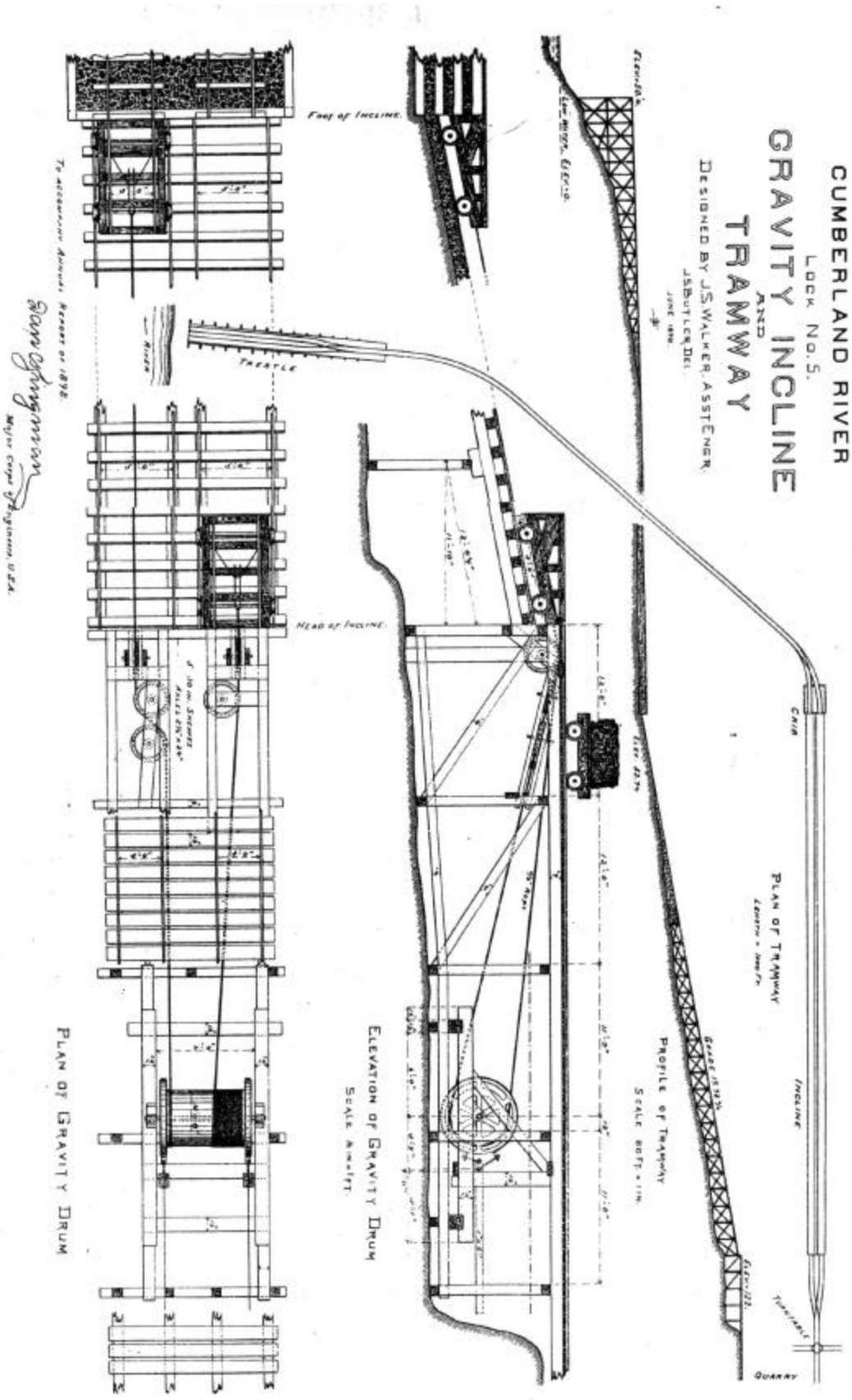
By June 1898 an examination of the riverbank had been made and possible sites located for Lock and Dam B. The preferred site was located on the left bank, near Hollingsworth Landing, about 51 miles below Nashville. The submission of the site for approval was pending in July 1898, awaiting the completion of the maps (Annual Report of the Chief of Engineers 1898: 1876).

Figure 8: A traveler for hauling stone at Lock 4, 1894.

Work had been completed on the first four locks on the Upper Cumberland, Locks Nos. 1-4, as had the dam abutment at Dam No. 1. Current policy dictated that no further work was to be initiated at these sites before the completion of the remaining locks now under construction. Work was proceeding at a good pace at Locks Nos. 5, 6 and 7. At Lock No. 5 the concrete foundation of the lock was completed, the brickwork of the filling culverts was begun, stone was quarried, cut and stockpiled and the masonry in the lock walls was begun. A few problems arose; no doubt a common occurrence at all of the lock sits. The report of Assistant Engineer John Simpson Walker, included in the Annual Report of 1898, describes in detail leakage into the lock chamber from crevices under the cofferdam. A number of measures were employed to correct the problem, including concreting the crevices. Walker's report describes the concrete mixture used to seal the lock walls: "The concrete is composed of Portland cement, 4 ½ cubic feet; sand, 11 ¼ cubic feet; gravel, 12 cubic feet; broken stone, 13 cubic feet; the cement being one-ninth of the aggregate. This made, when thoroughly mixed and rammed, ninety-five one-hundredths cubic yard. Empire Portland cement, manufactured at Warners, N. Y., was used. The concrete was mixed and the stone broken by hand" (Annual Report of the Chief of Engineers 1898: 1887).

Masonry work on the lock walls was began but was halted when all of the available stone, 2,094 cubic yards, was exhausted:

A derrick was erected at the head of the lock to set the face of the culverts, the backing around the culverts, and build the upper end of the lock. Stone was delivered into the lock chamber and



igure 9: Gravity Incline Tramway.

> carried to this derrick on tram cars. A second derrick, erected at the lower end of the pit, set the lock walls as high as practicable with stone on hand, and then this derrick was moved ahead and the laying of masonry continued. While this derrick was being moved the gang of masons (3) were employed with the derrick at the head of the lock. A 12-inch course of pointed-face stone was laid from the recess quoin to upper miter sill on both the land wall and the river wall; a 2-foot 2-inch course of pointed face was laid from recess quoins to lower end of lock, leaving spaces for miter-sill hollow quoins. The walls were backed up as high as possible, leaving room for face stone and for stepping the work so as to permit a good bond when the work is resumed. All the joints in the backing were built up full with Portland cement mortar and spalls and left in such shape as to be easily cleaned when the work is resumed. Two thousand and ninety-four cubic yards of masonry were laid, at a cost of 88 cents per cubic yard for labor and $1.64 per cubic yard for labor and mortar (Annual Report of the Chief of Engineers 1898: 1887).

The stone to complete the masonry would come from a quarry located on the Rankin farm on the far side of the river, a short distance from the lock site. This quarry fulfilled the requirements of being located within low-water boating distance of the lock and being capable of supplying the 25,000 cubic yards of stone necessary for the lock, abutment, dam and bank protection. The site was selected and quarrying begun in the fall of 1897. A gravity incline plane, similar to the one described for Lock A, was constructed to move the stone from the quarry to the riverbank. Stone from the quarry was boated to the lock site where it was cut, the waste being used for filling, paving and riprap. The steamer *Susette* was employed in towing heavy material to Locks 5 and A and for transferring barges across the river at Lock 5. All work at the lock site was carried out by hired labor (Annual Report of the Chief of Engineers 1898: 1880).

At Lock Nos. 6 and 7 the work was being carried on under the continuous contract system, the contractor being McArthur Bros. Co. of Chicago. Work at the site of Lock No. 6 began in July 1897. In the year which followed temporary building were erected and the cofferdam built and pumped out. Excavation was begun for the lock foundation and the lower approach but was halted on December 21 because of high water. The site was also fenced with a wire fence and a tram track from the quarry to the lock site was built. The quarry, about one-half mile from the lock site, was opened in September. By July 1898 about 120 men were working at the quarry, 50 of which were stonecutters. Stone was quarried, cut and transported to the lock site on cars drawn by horses, four being employed for this task. By July over 3,983 cubic yards of dressed stone had been stockpiled at the lock site: 64.8 cubic yards of special stones, 733.4 cubic yards of pointed face stone, 976.7 cubic yards of squared faced rubble and 2,208.4 cubic yards of backing. In addition 2,300 cubic yards of dressed backing and 1,800 cubic yards of rough stone had been sent to Lock No. 7 for use in construction of the lock walls (Annual Report of the Chief of Engineers 1898: 1880-1881, 1889).

Construction at Lock No. 7 also began in July 1897. As at Lock No. 6, wire fence was placed around the site and temporary buildings erected for the work force and to shelter materials and machinery. The cofferdam was completed in mid-November and all of the tools and the work force were moved to the quarry site in Rome, Tennessee, about four and a quarter miles below the lock. The quarry was worked by a force of 100 men, under the direction of eight foremen. Sixty-five stonecutters were employed and a like number of bull pointers, derrick hands and laborers. Assistant Engineer John S. Walker described the equipment at the quarry: “The plant in use at the Rome quarry consists of 13 derricks, 12 of which have steam hoisting engines, 5 of which have bull wheels and steam swinging gear (1 derrick is served by horse power), 10 steam

drills, 1 baby steam drill, 2 quarry bars, 5 tram cars for stone, 2 dump cars for stone, 4 dump cars, 1-foot six-inch gauge for stripping, 1 gravity incline plane, double track, 183 feet long, operated by a double drum (4 feet diameter) and cable." By June 30, 1898 almost 10,000 cubic yards of dressed and rough stone had been transported from the Rome quarry to Lock No. 7 and was ready for masonry work to resume. The remaining obstacle to completing Dam No. 7 was overcome when the last tiny tract of land necessary to complete the abutment site, 36/100 of an acre, was finally acquired in April 1898 (Annual Report of the Chief of Engineers 1898: 1880-1881, 1889).

No construction activity took place at any of the remaining locks in the system between July 1897 and June 1898. The sites for Lock and Dam No. 8 had been approved and negotiations were underway to try to obtain the land by voluntary purchase. The lands needed for Lock and Dam No. 21 had been condemned and the Engineers were awaiting final action of the Department of Justice. The sites for the lock and abutment of Lock No. 22 had been acquired, but because of the limited funding allocated to Locks and Dams Nos. 21 and 22, only $18,593.79, it had been decided that the masonry at Lock No. 21 would be completed before beginning any work at Lock No. 22. The locks planned for the Smith's Shoals stretch of the Upper Cumberland were still more or less on hold. The sites had been approved and authority had been granted to acquire the land, either by voluntary purchase or condemnation, but no action had been initiated (Annual Report of the Chief of Engineers 1898: 1881-1882).

Over the next year construction activities at all of the active sites continued when water levels permitted. The masonry for the dam abutment was completed at Lock A and the cofferdam constructed. The bed of the lock was almost ready for masonry work to begin and three-quarters of the stone necessary to build the lock walls was stockpiled at the site. The cement was also on hand and a cement shed had been "erected for its protection." The stone necessary for filling the dam was also available, being refuse from the quarry. Construction at Locks Nos. 5, 6 and 7 proceeded more or less on schedule and were nearing completion. In the spring of 1899, Lieut. Col. Milton B. Adams replaced acting District Engineer Maj. Dan C. Kingman as District Engineer. In his annual report Adams estimated that to do everything necessary to make the Locks Nos. 1 through 7 operative, that is to complete the work in progress at Locks 5, 6 and 7, construct the approaches and abutment at Lock No. 1, and whatever else might prove necessary, would cost $898,740 and take two years to complete after the funds were appropriated (Annual Report of the Chief of Engineers 1899: 2240-2245).

Little had changed with regards to the other lock sites. The land for the abutment had been acquired at Lock No. 8 but the lock site had not. The sites for the lock and abutment had been acquired for Lock and Dam No. 21. The status of Lock and Dam No. 22 and the proposed locks on the Smiths Shoals section remained the same. The annual report of 1899 mentions Locks Nos. 9 to 20 for the first time, only to say that no surveys have yet been made to determine or select sites for these locks (Annual Report of the Chief of Engineers 1899: 2244-2245).

As the new century dawned work on the canalization continued in spite of inadequate appropriations and seeming public apathy concerning improvements made to the Cumberland. Since the project had first been proposed traffic on the river had changed dramatically. Between 1880 and 1900 only forty-nine new steam packets entered service on the Cumberland. At the

same time many old vessels were retired or disabled. Freight carried by steamboats had declined dramatically, especially on the lower river. Every one of the larger towns along the river served by a railroad now supported at least one general merchandise store. These stores carried everything including groceries, furniture, stoves, patent medicine, household goods, red flannel underwear, hardware and farm machinery. To obtain what they needed farmers needed only to travel into town. No longer was it necessary to write a letter to a merchant in Nashville ordering the merchandise, wait for its arrival via steam packet and have it delivered or make a trip to the dock to pick it up. Loss of the "light freight" trade to the railroads was just another in a series of serious blows to the steam packet trade (Douglas 1961: 226-228).

Trade on the upper river remained brisk, if somewhat curtailed. Lumber and livestock were still being carried on steamboats and would be for some years to come. Many small river towns had no rail access, and no roads to speak of, linking them with the outside world. These communities continued to depend on the river as an avenue of supply, and on steam packets to bring them everything they needed (Douglas 1961: 226-228).

By 1900 a few steam towboats had entered the Cumberland and were getting a fair amount of trade. But a system of handling commercial common carrier freight had not been perfected. The barges themselves were crude affairs and could only transport freight that could stand exposure to the elements, such as sand and gravel. River travel could never compete with the railroads in terms of speed. If river commerce was to remain viable some method needed to be found to move big volumes of slow moving material. The answer was there on the river – barges, barges that could be modified to haul almost anything. But rivermen had yet to see the barge as the answer to their woes; and perhaps the old steamboat men were simply loath to trade the beautiful, graceful packets for strings of unattractive, slow moving barges; were unwilling to give up a way of life they loved, even though circumstances were forcing them to do just that (Douglas 1961: 246).

As steam packets struggled to survive on the Cumberland, work on the system of lock and dams designed for their use slowly progressed. By early 1900 the cofferdam around Lock A was complete and 9,082 cubic yards of lock masonry had been laid. Almost all of the stone necessary for the masonry had been cut and stockpiled and the cement, sand and gravel were also on site. Most of the stone needed for filling the dam, riprapping and paving was also on hand as it was refuse from quarrying the dimension stone (Annual Report of the Chief of Engineers 1900: 2894-2892).

The masonry of the lock and the dam abutment at Lock No. 1 were also completed in the first half of the new century. In August 1999 a contract had been entered into with James E. Sloan & Co. of Nashville to complete the excavation of the approaches to the lock, grading the bank and placing the necessary bank protection. The work was in progress and was to be completed in December 1900. The masonry of the lock at Lock No. 5 was almost complete in June 1900, only a small amount of pointing remained to be done. Two thirds of the cofferdam had been removed and the fill placed in the space behind the land wall. The bank near the lock was graded and riprapped and the terreplein and a portion of the slope opposite the lock was paved. The abutment of the dam, filling behind the abutment, grading and riprapping the bank had also been completed. At Lock No. 6 the majority of the work consisted of excavation, paving, riprapping

and masonry work. This would be completed by the end of December 1900 if the schedule were met. Lock No.7 was completed in March 1900. There was no change in the status of any of the remaining proposed locks on the Upper Cumberland. In referring to Lock No. 21 District Engineer Lieut. Col. Milton B. Adams emphatically stated, as he had the year before: "There is no single lock, and perhaps it may be said no two or three locks in this system, the completion and operation of which would do as much for the commerce of the Upper Cumberland River as the completion and operation of Lock No. 21" (Annual Report of the Chief of Engineers 1900: 2892-2900).

Although Adams remained constant in his views regarding Lock No. 21 he had come to a new point of view regarding the direction in which improvement of the Cumberland River should progress. In his first annual report as District Engineer, Lieut. Col. Adams had recommended that all of the locks currently under construction be made operable as soon as possible. After fifteen months on the job, and with more knowledge of the Cumberland River Valley, he had come to a different conclusion. Rendering the eight locks operative would, in effect, only " . . . produce a lake-like reach of navigable water, extending from 41 miles below to 125 miles above Nashville, that would be lacking a navigable outlet during seven months of the year" (Annual Report of the Chief of Engineers 1900: 2893-2894). Instead Adams, now believed that it would be useless to make the locks operable in the absence of a navigable outlet leading to the Ohio River, or until the time that the improvements to the coal fields, that is, the proposed Smith's Shoals system of lockage, could be pushed to completion (Annual Report of the Chief of Engineers 1900: 2893-2895).

Adams estimated the cost of completing the improvements to the river below Nashville to be $1,714,500. Once the funds were available and the lock sites secured he believed that the work could be accomplished in two years. On the other hand, his estimate for completing the improvements above Nashville came to $6,805,000. With the funds available and the lock sites secured it would take, he believed, eight years for the work to be completed. He believed that more immediate benefits would be gained by affording all-year navigation to the Ohio River from Nashville and from Carthage than by affording the same on the upper river, to reach the coalfields there. The improvement of the upper river would take four times as long, and cost four times as much as the improvement of the lower river and he believed that earlier and larger returns might be expected from improving the lower river. He went on to say: "Therefore it seems well warrantable that early provision be made for the construction of 6 more locks and accessories below Nashville, and that the 7 locks (1 now built) constituting the lower river system of improvement, as well as the other 7 locks now built and constituting the lower portion of the upper river system of improvement, be made operative together at the earliest possible admissible date. It seems impossible to urge the course that has just been stated with too much vehemence, being apparently the only way of securing a return for the expenditures already incurred and that may hereafter be incurred within a reasonable time and for a reasonable additional outlay" (Annual Report of the Chief of Engineers 1900: 2894).

In spite of Adam's urging little was accomplished on the Cumberland River improvement project over the next two years. The masonry of the lock and the abutment at Lock A were completed by the end of June 1901 but no appropriations were made for the improvement of the Lower Cumberland River in the following year and all operations at Lock A were once again halted.

The Upper Cumberland fared a bit better. Work on the approaches and grading underway at Lock No. 1 continued, only to be delayed in November 1900 because of high water. It was May 1901 before the work could be resumed. At Lock No. 5 a cofferdam was built to enclose the lower approach to the lock using timber salvaged from the cofferdam around the lock. A portion of the lower approach was excavated and a rubble wall built in front of the rough faces of the excavation to keep the bank from collapsing and to prevent injury to vessels entering the lock. The bank was partially riprapped, a portion of the cofferdam removed, and the lower approach concreted. The bank above and below the lock was then graded and riprap installed. By the end of June 1901 the lock walls and dam abutments were completed at Locks Nos. 6 and 7. There was no change in the status of Locks Nos. 2, 3, 4, 8 or 21 (Annual Report of the Chief of Engineers 1901: 2408-13).

In the Annual Report issued in July 1901 Adams again stressed the importance of improving the lower river: "If large boats could be assured, an all-year stage of water between Nashville and the Ohio Valley, it is probably not saying to much that a reduction of 30 to 40 percent in most freight charges to and from Nashville, Clarksville, and perhaps other points, would inevitably follow, and I do not hesitate, therefore, to ask for the entire sum that will be required to carry the lower river scheme of improvement and the lower portion of the upper river scheme of improvement to completion at an early day . . ." Adams requested the sum of $1,714,500 to complete the work described, but his request would be in vain. When Adams, who was still relatively new to the Cumberland Valley, made his recommendation to shift the focus of improvement to the lower river, at the expense of improvements to the upper river, one wonders if he had any idea of the controversy which he was to unleash (Annual Report of the Chief of Engineers 1901: 2409; Johnston 1978: 154-155).

The money Adams requested was not forthcoming, in fact no new appropriations were made for improvement of the Cumberland River, and between July 1, 1901 and June 30, 1902 construction activities were halted at all but Locks Nos. 1 and 5, and the work required at those sites was minimal. The work in progress at Lock 1, which had been halted by high water the year before, was resumed in May and completed on December 27, 1901. At Lock No. 5 riprap was quarried and placed on the bank behind the lock wall and above and below the pier derricks, an expenditure of $12,305.45. In his annual report Adams repeated his request for appropriations and again stressed the importance of continuing the improvement of the Lower Cumberland (Annual Report of the Chief of Engineers 1902: 1696-1697, 1700-1701).

The Amended Act of June 13, 1902 provided some funds for the continued improvement of the Cumberland, $180,000 for the lower river and $200,000 for the upper river. Although small, the amount did enable work to resume. Proposals were solicited for the construction and erection of four pairs of steel lock gates, operating mechanism and filling valves to be installed at Locks A and 1. When no acceptable bids were forthcoming new designs for both timber and metal gates were drawn up, timber gates to be installed if no reasonable bids for steel gates could be obtained. While waiting for acceptable proposals miscellaneous work continued at Lock A. The bank was riprapped, fill was placed behind the land wall, the cofferdam was removed and stone broken for use as paving and fill. On the abutment side excavation continued, masonry was laid and fill placed behind both upstream and downstream walls (Annual Report of the Chief of Engineers 1903: 1581-1582, 1587).

Bids were also solicited for the construction of a floating plant to be used in lock and dam construction on both the Upper and Lower Cumberland. Ed. J. Howard of Jeffersonville, Indiana was awarded the contract of $28,268 for the construction of two steam tenders, two dump scows, six decked barges and two derrick-boat hulls which made up the plant (Annual Report of the Chief of Engineers 1903:1582).

There was little to be done at Lock No. 1 while waiting for acceptable proposals for the lock gates. The lock, approaches and abutment protection had been completed in September of the previous year by the contractors, Messrs. James E. Sloan & Co. Work at Lock No. 2 consisted mainly of repairs to temporary buildings and to installing a retaining wall and riprap to prevent caving of the bank below the lock. The work on the bank was begun in August 1902, but had to be halted in December because of high water. At both Locks Nos. 3 and 4 the work of constructing the abutment was begun. The year was mainly spent in preparatory work – organizing the work force, collecting materials, making repairs to the access road and temporary buildings, erecting derricks and so on. It was decided that although the abutment at Lock 4 would be built of stone the abutment at Lock No. 3 would be built of concrete. Work at Lock No. 5 was confined to riprapping the bank and quarrying additional stone for riprap (Annual Report of the Chief of Engineers 1903: 1585-1597).

An acceptable proposal for the lock gates, operating mechanism and filling valves for Locks A and 1 was received in the late fall of 1903. The contract went to the Penn Bridge Company of Beaver Falls, Pennsylvania, who entered a low bid of $32,950 for steel gates with flat plates. The contract called for the gates to be in place by September 30, 1904. In January 1904 advertisements were made for furnishing and delivering 1,470, 000 feet, board measure, yellow-pine timber for Dams A and No. 1. The contract went to W. C. Rogers of Hattiesburg, Mississippi, who delivered the timber before the end of June (Annual Report of the Chief of Engineers 1904: 2340).

Work at Lock A resumed in late February 1904 when the labor force, who had finished at Lock No. 3, arrived on site. While waiting for the delivery of the lock gates and timber for the dams stone was quarried for riprap, and the river above and below the lock and at the abutment was dredged. Other work included erecting derricks, counter hewing timbers for dipper handles and sills for locks, making scale boards and repairing machinery. When the timber for the dam was received, all 952,000 feet, board measure, it was unloaded and piled at the dam construction site (Annual Report of the Chief of Engineers 1904: 2340).

Preparations for putting in the dam also occupied most of the spring of 1904 at Lock and Dam No. 1, after work resumed April 1. The crew, who had been sent from Lock No. 4, erected temporary buildings including a blacksmith's shop, machinery shed, living quarters for the laborers, a kitchen and a dining hall. One permanent building, a brick storehouse, was also constructed. Construction also began on a rock fence to replace an existing wooden fence at the lock (Annual Report of the Chief of Engineers 1904: 2344).

The dams that were built at Locks A and No. 1 in 1904 were timber crib dams. The same basic design would be used for all of the dams on the Cumberland, with the exception of the dam at

Lock 21, which was constructed of concrete. Timber crib dams were built of squared timbers, usually ten by ten inches, stacked up "log cabin fashion," forming compartments ten feet square. The corners of each compartment, or crib, were held in place with long steel rods. After being placed in the river the cribs were filled with stone. The top of the dam was then capped with ten inch square timbers which kept the stone in place. The upstream vertical face and the upstream slope were sheathed with two and three inch planks which were driven to rock. This wood sheathing, replaced by steel in some of the later dams, helped to stabilize the structure, as did the stone and gravel backfill placed on the upstream side of the dam. The downstream slope of the dam was covered with ten by ten inch timbers. This heavier protection was needed on the downstream side because this portion of the dam was subject to violent attacks by drift and saw logs (Butler 1916: 4; Johnson 1978: 150).

By the end of February 1904 the abutment was finished at Lock No. 3 and the work force was dispatched to Lock A to resume work there. In addition to the concrete abutment, a retaining wall to protect the lower approach to the lock was built and the banks of the abutment and lower approach were riprapped. Maintenance included leveling and bracing all of the temporary buildings, reshingling the kitchen, quarters and blacksmith shop and building a brick flue in the living quarters. Bins were also constructed to hold sand and gravel (Annual Report of the Chief of Engineers 1904: 2344-2345).

The masonry abutment at Lock No. 4 was completed at the end of March 1904 and operations at Lock 4 closed. Its work crew was sent to Lock No. 1 to resume operations there. As at Lock No. 3, a retaining wall to protect the lower approach to the lock was built and the banks of the abutment and lower approach were riprapped. Miscellaneous work included erecting derricks, building tram track, setting machinery and making minor repairs to machinery (Annual Report of the Chief of Engineers 1904: 2345).

Over the next year Dam A was completed, a lockmaster's house built, and the locks made operational on November 26, 1904. After that time, work at the site was mainly confined to the daily operation of the locks and routine maintenance of the property. Several problems did, however, develop in the months that followed. The bank below the abutment caved to such an extent that it was necessary to grade and riprap it 500 feet below the U. S. property line. The riprap was boated across the river above the dam, from the lock side, elevated on derricks, placed on cars and hauled 1,000 feet where it was dumped and hand placed on the newly graded slope. Several months later the downstream end of the bank on the U. S. land below the lock caved and required the same attention. The newly constructed dam also had its problems. Drift was causing injury to the structure. It was repaired "by filling stone in the void spaces under the breaks in the lower half of the lower slope and closing them with concrete having an average depth of 3 feet 9 inches." The repairs seem to have been effective (Annual Report of the Chief of Engineers 1906: 1504).

Lock and Dam No. 1 was also completed and fully operational by the end of November 1904. The only construction activities at the site involved the construction of a lockmaster's house, an expenditure of $2,146.01, painting the house inside and out, and conversion of a temporary building into quarters for a lockman. Miscellaneous maintenance included painting the roof of the machinery shed "with a coat of asphaltum roofing paint," whitewashing temporary buildings

and repairing the rock fence along the public road (Annual Report of the Chief of Engineers 1906: 1506, 1511).

On June 15, 1905 Lawrence D. Weaning of Cleveland, Ohio was contracted to supply two steel lock gates, filling valves and operating mechanism for the dam at Lock No. 2. The timber necessary for the construction of the dam was delivered by the end of October 1905 and preparatory work on the dam continued. By the end of June 1906 the filling valves and maneuvering appliances had been placed in the lock and the upper gate was being installed. Unfortunately, an unusually high stage of water in the river, and a lack of labor, delayed the installation of the lock gates until November 6, 1906. Other work at the site consisted of constructing guard piers, dredging the dam site and the lower approach to the lock and removing deposits in the lock chamber (Annual Report of the Chief of Engineers 1906: 1506-1507).

On September 22, 1905 a contract was entered into with Continental Engineering and Contracting Company of Buffalo, New York to build a concrete lock and dam at the site chosen for Lock and Dam No. 21. The date of completion was set at December 1, 1907. Six months later, on March 9, 1906, Port Huron Shipbuilding Company of Port Huron, Michigan was awarded the contract to supply and install the gates and other necessary mechanisms necessary to make the lock operational. The gates were to be installed within forty *available* working days after the completion of the masonry. The insertion of the word 'available' in the contract is notable. Weather, high water and other uncontrollable vagaries of the river rendered working impossible on many days out of the season, even during the 'normal' working season. Between October 1905 and June 1906 temporary buildings were put up, the plant was installed, cement was received and stored, a portion of the cofferdam was constructed and quarrying of stone and removal of earth and rock began at Lock No. 21 (Annual Report of the Chief of Engineers 1906: 1507).

As of June 30, 1906 no provision had been made for the completion of Locks and Dams Nos. 3 through 7 on the Upper Cumberland. The report of District Engineer Major H. C. Newcomer did, however, stress the importance of locating sites and purchasing lands for the proposed Locks B, C, D, E, F and G on the lower river. He asked for $400,000 to push the survey forward. His request was no doubt made in view of the decision of the Board of Engineers five months earlier, a decision which ended an argument that had been raging for almost six years (Annual Report of the Chief of Engineers 1906: 1507).

When District Engineer Lieut. Col. Milton B. Adams, in 1900, made his initial recommendation to direct efforts toward improving the Lower Cumberland, thereby providing a year-round navigation channel to the Ohio River, he opened a hornet's nest of controversy. Adams felt that improvements made to the Upper Cumberland could not be justified as cost effective, whereas those proposed for the Lower Cumberland would prove to be highly cost effective, and of great benefit to a large number of communities and to commerce on the river in general. In Annual Reports issued in 1901 and 1902 Adams continued to press his argument, stating in 1902:

> The section of the river below Nashville on which two locks are built is twice as worthy of improvement as the section between Nashville and Carthage on which six locks are built, and the section between Nashville and Carthage is ten times worthy of improvement as the section above Carthage on which no work has been done. However, it is not claimed as far as learned

> that the outlay for canalization is warrantable except mainly for the purpose of reaching coal fields alleged to be there. These fields should be vast to warrant an expenditure of $6,000,000 in transportation facilities. . . My recommendation therefore is that the section below Nashville be pushed to completion before everything else, that the section between Nashville and Carthage be completed next; but I am inclined to regard the section above Carthage as unworthy of improvement except through a fostering care of the Government by maintenance of existing open channel work (Annual Report of the Chief of Engineers 1902: 1704).

Adams went so far as to write to Chief of Engineers George L. Gillespie in April 1902: " . . . the fact of the matter is that the way Congress appropriates for this river may be likened to child's play. For if it is really the intention to canalize the river and to derive benefits from the improvement the work should be concentrated on the lower river" (Johnson 1978: 155). Adams' position provoked an immediate and loud out-cry of indignation. The Cumberland River Commission, originally the Cumberland River Improvement Association, dismissed his report as fanciful. The Retail Merchants Association of Nashville called for Adams' immediate removal as District Engineer. Whether or not the Association's demand was answered or not is unclear, but in April 1902, Adams was replaced by Capt. William J. Barden as District Engineer. In 1903 the Cumberland River Commission issued a report, addressed to the Governor of Tennessee, stressing the bountiful resources of the Upper Cumberland. They spoke against Adams' policy saying: "Such a policy as advocated by the local engineer would, it appears to us, mean an abandonment of the upper-river improvement for many years, if not forever. We are strongly of the opinion that, the locks between Nashville and Carthage having been built at so great a cost, the dams should be built; and they should be put in operation with the least possible delay" (Bryan, et. al. 1903: 15). They concluded, saying that the improvement of the Upper Cumberland was critical to the towns along its length and exhorted the Governor to take action: ". . . the work of exploiting the resources [of the Upper Cumberland] and presenting the merits and claims of the Cumberland River Valley upon the bounty of Congress should not, in our opinion, be permitted to rest, but should be continued until the whole scheme of improvement is completed" (Bryan, et. al. 1903: 22). Matters came to a head in late 1905 and the Board of Engineers of Rivers and Harbors Committee convened at the Nashville Board of Trade in February 1906 to decide the future of Cumberland River improvement. Many prominent individuals addressed the board, stressing the vital importance of the canalization project to the Upper Cumberland Valley. In spite of the testimony the Board agreed with the recommendations of the District Engineer concerning improvement of the river above Carthage. Their decision may be seen as a compromise. The construction of all locks and dams above No. 7, at Carthage, with the exception of No. 21, at Burnside, was suspended, indefinably. Locks Nos. 2-7 were already completed but their dams were not. Those dams were to be built and the locks made operational. Lock No. 21, at which construction had barely begun, would also be completed. From this point forward improvements on the upper river would be limited to those locks and dams already under construction and every effort would be made to speed the completion of proposed Locks and Dams B-G on the lower river (Annual Report of the Chief of Engineers 1900: 2893-2894; Annual Report of the Chief of Engineers 1901: 2408-1409; Annual Report of the Chief of Engineers 1902: 1705; Bryan, et. al. 1903: 15, 22; Johnson 1978: 155).

Lock No. 21, far separated from the other locks on the Upper Cumberland, was seen as a special case. Its construction had been authorized with the idea of providing a pool for loading barges, which would be able to float down to Carthage on the crest of a rise, and thence down to

Nashville. When its construction was authorized in 1905 it was probably with the idea that it would, eventually, be connected to the rest of the canalization project, working toward it from both down river and the highest proposed lock upriver (Johnson 1978: 155).

Between July 1906 and June 1907 a survey party was organized with the purpose of locating sites for the proposed locks on the lower river. Work at Lock A, other than the day-to-day operation of the lock, consisted mostly of minor construction of a domestic nature. Three outhouses, a cistern for the lockman's house and a kitchen for the lockmaster's house were built, no doubt adding to the comfort of the lock keepers stationed there. The roofs of temporary buildings at the site were patched and the buildings whitewashed. The problem of bank erosion continued and 620 cubic yards of stone were placed on the bank at the lock end. The damage to the dam caused by drift was partially repaired by placing eleven pieces of sheeting next to the crest of the dam to replace broken timbers. Several breaks had also been noted on the lower face of the dam but high water levels had not permitted their thorough inspection (Annual Report of the Chief of Engineers 1907: 1611, 1618).

As survey work began on the lower river construction continued at Locks Nos. 2 and 21 and readying the site for the construction of the dam began at Lock No. 4. Construction at all three sites faced delays in the fall of 1906 occasioned by repeatedly high river levels. The delay in erecting the lock gates at Lock No. 2 made it impossible for the dam to be completed according to schedule. The dam was begun on August 13, 1906. Work was interrupted by high water from August 19 to 23 and again from September 6 to 18. After one day of work construction was again halted from September 19 through November 6. On the November 18 the water began to rise once more and, bowing to the inevitable, work on the dam was suspended for the season (Annual Report of the Chief of Engineers 1907: 1613).

Construction activities at Lock No. 2, in addition to building the dam, included pumping and cleaning 2,178 cubic yards of deposit from the lock pit, framing the movable dam for the upper end of the lock, quarrying 3,582 cubic yards of stone, riprapping the bank below the lock, laying 118.56 cubic yards of paving on the terreplein, dredging 10,450 cubic yards of sand and gravel from the lower approach to the lock and the foundation to the dam, finishing the guard wall and making repairs to the plant. The work force also built a barge for use on the survey of the Lower Cumberland. Houses for the lock force were begun, and a stone foundation was built under the storehouse (Annual Report of the Chief of Engineers 1907: 1613).

Preparations were underway at Lock No. 4 to begin construction on the dam. A hired labor force had been kept busy moving derricks and other machinery from Lock A to Lock 4. Temporary storage buildings had been readied for the storage of cement and an order had been given for 1,000 barrels of Portland cement that would be used to build the guard wall. An incline and a trestle had been built to unload material and sand, gravel and coal were already arriving on site. One hundred eighty feet of bolt holes had been drilled. Here, as at Lock No. 2, high water was a problem, principally in interfering with the delivery of needed materials (Annual Report of the Chief of Engineers 1907: 1614).

Figure 10: Form for the construction of the guard wall at Lock D in 1917.

Not only high water but a shortage of labor was also causing problems at Lock No. 21. Construction had been seriously delayed and the amount accomplished had fallen far short of expectations for the season. The lock gates had been delivered but could not be erected because the masonry work was not finished. The cofferdam for the lock had been completed and excavation of the lock pit was proceeding. Five hundred eighty-five cubic yards of concrete foundation had been poured. A portion of the abutment had also been excavated, the bank below the lock had been graded and the foot protected with a mound of riprap. Miscellaneous work included repairing the tram track and trestle and overhauling the mixing plant (Annual Report of the Chief of Engineers 1907: 1614).

By June 1908 the survey party on the Lower Cumberland had run a line of levels from Lock A to Smithland and had developed sites for Locks C and D. The site for Lock E was partially developed and it was expected that E and the site for Lock F would be fully developed by the end of the summer. The dam at Lock A still needed repair. Machinery, derricks, sand, gravel and other materials were readied but high water prevented much from being accomplished. Other work at the site consisted of mortaring the joints of the paving on the terreplein and cleaning and painting the lock gates. The only construction activity was building a coalhouse for the lockmaster (Annual Report of the Chief of Engineers 1908: 1684, 1694).

Activities at Lock No. 1 were of much the same nature as those at Lock A. The lock gates were cleaned and painted. One outhouse was built, a porch added to the Lockman's house and the Lockman's house was painted (Annual Report of the Chief of Engineers 1908: 1694).

Work on the dam at Lock No. 2 had closed in November 1906 but was able to resume the following year when river levels dropped. It seems to have been a productive season. The lower approach to the lock was dredged, removing 17,540 cubic yards of sand and gravel. The cofferdam was removed and 829 cubic yards of mud was removed from the lock pit. The terreplein was excavated, graded and paved. Gauges were cut on the lock walls and a house for the lockmaster was built, at a cost of $3,616.64. About 300,000 feet, board measure, of lumber had been used in constructing the dam, which was filled with 2,034 cubic feet of stone. Work on the dam at Lock No. 2 had been plagued by numerous rises in the river but the dam was finally closed and the lock put into operation on October 9, 1907. District Engineer Maj. William W. Harts estimated the cost of the dam, exclusive of excavating the gravel and mud overlaying the rock on which the dam rested, to be $23,073.02 (Annual Report of the Chief of Engineers 1908: 1687).

Within six months after the opening of the lock problems developed with the filling valves and a submarine diver was employed to make repairs but it seems not to have been enough. The annual report for Lock No. 2 ends: "It is proposed to back up the dam and repair the filling valves when the stage of water permits" (Annual Report of the Chief of Engineers 1908: 1694).

When Lock and Dam No. 2 was completed in October 1907 the work force and the plant were moved to Lock No. 3 where preparation were made to make the lock operational and begin construction on the dam. A contract was already in force with the Penn Bridge Company to supply the gates and filling valves and proposals were solicited for lumber in November. The labor force was employed in building cribs for the derricks and erecting the trestle. A barge, 100 by 22 by 5 feet, was constructed. A shed was built for storing cement. The lower approach to the lock and the foundation for the dam and guard wall were dredged, removing 9,140 cubic yards of sand and gravel. The masonry was prepared for the lock gates and 392 linear feet of bolt holes were drilled for anchor bolts, at a cost of one dollar per linear foot. Two thousand eight hundred ninety-one cubic yards of stone for the dam was quarried and another 3,653 cubic yards delivered. By May 1908 J. K. Joice, of Chicago, Illinois had delivered 453,627 feet, board measure, of lumber to Nashville on board barges and it had been transferred to the site, unloaded and stored. Sand and gravel, 1,308 cubic yards of it, had also been delivered, unloaded and stored. By the end of June, Penn Bridge Company had delivered the gates and filling valves for Lock 3. The company had also made delivery of the gates and valves for Locks 4 and 5 and the filling valves for Locks 6 and 7 (Annual Report of the Chief of Engineers 1908: 1688).

At Lock No. 4 work during the low-water season was also directed toward making the lock operational. Eight hundred feet of holes for the anchor pins and rods were drilled. The pins and rods were placed and grouted. The guard wall and cofferdam were cleared of 1,300 cubic feet of mud and a reinforced concrete guard wall was built. Gauges were cut on the lock walls and the Government road was repaired (Annual Report of the Chief of Engineers 1908: 1688).

Preparations at Lock No. 5 were much the same as those at Lock No. 3. Derricks were installed and machinery erected. The tram track from the quarry to the bluff was graded and the track repaired and eight tram cars rebuilt. The masonry of the lock was prepared to receive the gates and 755 linear feet of holes for the anchor bolts were drilled. A shed was built in which to store cement and a cofferdam was built at the lower end of the lock. The work crew unloaded and stored 1,315 cubic yards of sand and gravel. The contract for timber made with J. K. Joice of Chicago included timber for the dam at Lock No. 5, 850,816 feet, board measure, which had been delivered and stored by the end of June 1908 (Annual Report of the Chief of Engineers 1908: 1688).

Things were not going well at Lock No. 21. The lock gates, which had been delivered in February 1907, were still not erected because the masonry was not finished. Between July and December 1907 a concrete retaining wall was built below the guide wall. A supplemental contract had been made with the contractor for the construction of a concrete guide wall for the lump sum of $22,929 but practically nothing had been done on this wall. The District Engineer was not satisfied with the work done under the contract with Continental Contracting and Engineering and Contracting Company and after two years of work on Lock No. 21 the contractor "became financially unable to proceed with his contract" (Annual Report of the Chief

of Engineers 1908: 1689). In fact, the company had lost $100,000 over the course of the two years. By the authority of the Chief of Engineers, the contract with Continental Contracting and Engineering and Contracting Company was annulled in May 1908 and a hired labor force was sent to take charge of the work (Annual Report of the Chief of Engineers 1908: 1689-1690).

When Junior Engineer John S. Butler, who was sent to oversee the work at Lock No. 21, arrived at the site on June 1 his remarks concerning the work of the contractors was not complimentary.

Figure 11: Lock 21 in 1908 showing damage from flooding.

The final season of work the contractors, knowing that failure loomed, had undertaken only the easiest work, without regards of the consequences to the project as a whole. As a result much of the work was left in bad shape for the resumption of operations. Much of the machinery was in poor repair and was in need of a complete overhaul. The abutment site and the lock side had suffered considerable erosion because excavation had been begun and left open. The form that the contractors had used for the lock walls was not satisfactory, and as a result, the face of the wall had many rough offsets (Butler 1909: 2-5)

Over the next six months the cofferdam was repaired and pumped out, machinery replaced and the plant overhauled to prepare for the resumption of active operations. Plans were made to carry forward the work on the lock walls and lower guard wall but little could be accomplished because the cement left by the contractors had been left out in the weather and much of it had to be discarded. Paving for bank protection on the lock side and abutment side was also delayed. One of the most serious problems encountered by John Butler was the delivery of suitable stone for riprap and crushers. There was plenty of stone at the old quarry; the problem was getting it to the lock and abutment sites. Stone could simply not be delivered fast enough to allow work to progress at an acceptable rate. John Butler described the problem in a progress report to District Engineer Colonel W. W. Harts:

> Now stone can be boated only when the river is from one foot to three and one-half feet on the gauge. For example, to deliver stone from the quarry to the abutment it will be necessary to go through the following operations: - 1st., quarrying the stone and throwing it over the bluff: 2nd., gathering up the stone, requarrying it in suitable size for its purpose, loading on cars with derrick, tramming to river derrick and loading on barge: 3rd., boating to head of island: 4th., loading on 4-yd. tram cars by hand: 5th., tramming to loading pier and dumping on barge: 6th., boating across river to proposed unloading derrick and loading on cars on top of tram track trestle on abutment side: 7th., hauling 1-yd. cars along top of bank and dumping for use in riprap: 8th., delivering the stone to its place of deposit and placing riprap (Butler 1909: 8).

Figure 12: Trimming concrete at Lock 21, 1908.

The delivery of necessary materials, including coal and cement, was delayed by low water making steamboat navigation impossible. Labor, too, was a problem. Butler reported that initially the local population was eager for employment but after a pay-day or two would disappear. To alleviate the problem fifty-five laborers and mechanics were brought from Nashville. In January of 1909, one receiver of materials, one surveyor, five foremen, ninety-five laborers, six enginemen, three stokers, seven carpenters, one blacksmith, two cooks, two waiters and one kitchen help were employed at the site (Annual Report of the Chief of Engineers 1908: 1689-1690; Butler 1909).

In addition to problems the contractor had left behind there were money problems as well. Estimates placed the shortfall at about $85,000. Even that would not be enough. The unpredictable Cumberland had thrown a monkey wrench into the plans once more. The District Engineer reported: "The lock, and more especially the abutment, are subject to flanking by the river at high stages, especially after the construction by the dam, which, having a lift of about 19 ½ feet, may be expected to increase the action on the banks at medium and high stages. It is proposed to do the necessary protection work on the banks before building the dam, as it is deemed inadvisable and unsafe to complete the dam before the banks are secure" (Annual Report of the Chief of Engineers 1908: 1690). It was estimated that the added protection would cost $44,000, in addition to the $41,000 that had already been added to a new estimate for completing the dam (Annual Report of the Chief of Engineers 1908: 1689-90).

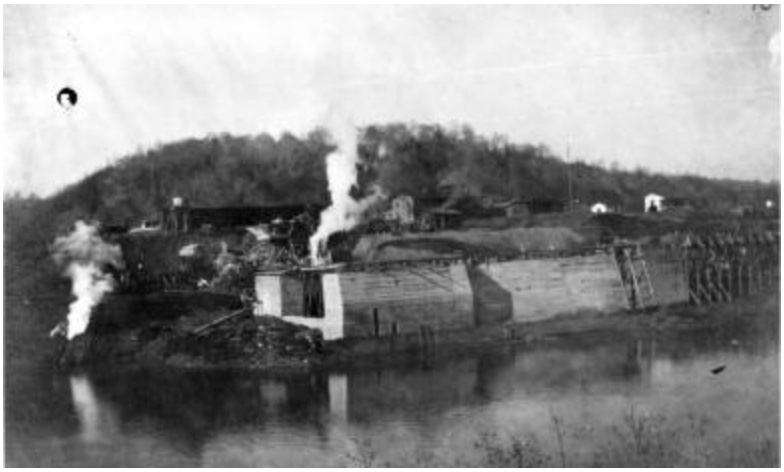


Figure 13: General view of Lock 21, 1908.

While John Butler struggled with conditions at Lock No. 21 repairs to the dam at Lock A were made. Three thousand seven hundred and fifty seven cubic yards of concrete were employed in repairing the lower slope of the dam entirely across the river, while 900 cubic yards of stone were placed above the dam. Activities at Locks Nos. 1 and 2 were confined to normal maintenance, including dredging the lock and approaches (Annual Report of the Chief of Engineers 1909: 1686).

At Lock No. 3 all of the preparations for opening the lock were well underway by the early fall of 1908. The masonry of the lock was prepared to receive the gates and maneuvering appliances. The lower approach to the lock was dredged, as were the cofferdams at the upper and lower end of the locks, removing 6,643 cubic yards of sand and gravel. A concrete guide wall was built and the dam was finished. The report on the cost of the dam is revealing:

> . . . the dam was built at a total cost of $25,574.20, consisting of 3,745 cubic yards gravel and sand excavated at a cost of 7.34 cents per cubic yard; 429,121 feet b. m. lumber at $28.51 per M feet b. m. (paid for in previous fiscal year). This lumber was framed and placed at a cost of $6.17 per M feet b. m.; the cost of plates, nails, boat spikes and drift bolts was about $2.92 for each thousand feet b. m. of lumber. Three thousand five hundred and sixty-three cubic yards of stone, solid measurement, were quarried, at a cost of $1.20 for quarrying, 5 cents for royalty, 40 cents for towing and 65 cents for placing in dam, making a total of $2.31 per cubic yard for stone placed in the dam; 5,320 cubic yards of sand and gravel were dredged and used to back up the dam at a cost of 8.34 cents per cubic yard" (Annual Report of the Chief of Engineers 1909: 1680).

The dam was completed and Lock No. 3 placed in operation on October 15, 1908. Two lock houses, at an average cost of $2,968.98 each, and a blacksmith shop, $266.37, were constructed before the end of June 30, 1909 (Annual Report of the Chief of Engineers 1909: 1680).

The work force at Lock No. 4 continued to prepare the lock for operation. A contract was awarded to W. C. Rodgers, of Hattiesburg, Mississippi to supply the 700,000 feet, board measure, of lumber necessary for constructing the dam. The masonry for the lock gates and maneuvering appliances was prepared and the lock gates were erected. Much of the work concerned, as usual, the removal of sand, gravel and rock. Rock was removed from the channel below the lock, sand and gravel were excavated and removed from the site of the dam, deposits were removed from the culverts at the upper end of the lock and 5,040 cubic yards of sand and gravel were dredged from the lower approach to the lock. By June 1909 the lock, with the exception of the dam, was finished. The masonry for the lock houses had been laid. Six thousand five hundred fifty cubic yards of stone, solid measurement, had been quarried and delivered to the lock, ready to be used for filling the dam. In preparation for the work to come a trestle had been built and a derrick erected for unloading supplies (Annual Report of the Chief of Engineers 1909: 1680-1681).

Late fall and early winter of 1908-1909 saw the highest water in the river in almost two decades. From the early winter of 1908 until mid-summer of 1909 it was impossible to do any work whatsoever in the river. Because of the unusual duration and intensity of the high-water season construction activities were greatly hampered at Locks Nos. 5, 6, 7 and 21 (Annual Report of the Chief of Engineers 1909: 1680-1681).

In the last half of 1908, about 225 feet of cofferdam was built at the upper end of Lock No. 5 and fifty feet at the lower end of the lock. The lock gates were erected under contract and the guard wall, containing 846 cubic yards of concrete, was completed. About one-third of the dam was completed before high water levels forced a suspension of work in the river that lasted from January 1 until the late summer of 1909. By June 30, 1909 all that remained at Lock No. 5 was to finish the dam (Annual Report of the Chief of Engineers 1909: 1681).

Work at Lock No. 6 was resumed on December 20, 1908 but the continued high water prevented any work from being done in the river. The work crew did construct an office building with the basement fitted up for storing cement, a storehouse and a blacksmith shop on the grounds of the lock. The laborers' quarters and kitchen no longer needed at Lock No. 1 were transported to Lock No. 6 and rebuilt at a cost of about $550. Fifteen hundred barrels of cement, for use in building the guard wall, were purchased and stored. A trestle and derrick for unloading material were erected and a tram track built. The masonry of the lock walls and the abutment of the dam were completed before the end of June 1909 and the preparation of the masonry for the lock gates and maneuvering appliances was also partially completed (Annual Report of the Chief of Engineers 1909: 1681).

Construction activities resumed at Lock No. 7 in mid-February 1909. Temporary quarters, including an office building, a storehouse and a blacksmith shop were built at a total cost of $2,312.37. A trestle and derrick for unloading material were constructed and tram tracks laid. A number of buildings were moved to the site, including a laborer's quarters from Lock 2, a kitchen from Lock A and a cement shed from Lock 5. The materials needed to build the guard wall and so on were purchased and stored: 1,500 barrels of cement, 240 cubic yards of sand, and 525 cubic yards of gravel. The masonry of the lock walls was completed and the crew at the site was able to partially prepare the masonry for the lock gates and maneuvering appliances, but as at Lock No. 6, continuous high water prevented the work from pushing forward. The District Engineer reported in June 1909: "High water has continuously prevailed and work in consequence could not be prosecuted. Since January 1, 1909, water has not been low enough to prepare masonry for installing the filling valves either here or at Lock 6. Such has not been the case before within the past eighteen years" (Annual Report of the Chief of Engineers 1909: 1681-1682).

In the first half of 1909, excavation of the dam abutment, construction of the lock masonry, the guide wall and the lock keeper's house occupied the hired labor force at Lock 21. Work at the lock seems to have progressed slowly. By June 30, 1909 an estimated 60% of both the lock wall and the guide wall was complete. The lockmaster's house was almost finished, the projected cost being $4,333.54. The report on the work accomplished is rather cryptic, indicating only "quantities of work accomplished" rather than what was actually done and where it was done. For example, the entry for the lock reads: "Lock – embankment, 689 cubic yards; grading bank, 2,117.7 cubic yards; concrete, 4,022.2 cubic yards; riprap, hand placed, 931.8 cubic yards; stone filling, 248.4 cubic yards; rock excavation, 218.3 cubic yards; earth excavation, 4,113 cubic yards; irons placed 16,778 pounds" (Annual Report of the Chief of Engineers 1909:1682).

The District Engineer added a PostScript to the description of work at Lock No. 21. When completed the dam at Lock No. 21 would back up the water enough to add about four feet of additional depth to the ruling low-water stage at Burnside. This, Maj. Harts concluded, would make the harbor at Burnside a very useful anchorage for boats when the river was too low for navigation, as well as affording excellent opportunities for the transportation of freight from the Queen and Crescent Railroad, which crossed the river at Burnside. The problem was that the there was no public access to the river. The steamboat line which controlled all of the privately owned steamboats on that portion of the river, the Burnside and Burkesville Transportation

Company, had entered into an exclusive agreement with the railroad which stated that no freight could be handled between the railroad and the river by any other line unless consent was granted by the Burnside and Burkesville Transportation Company. This agreement prohibited any independent steamboats from landing at Burnside without prior permission, nor could any freight be shipped by rail, to or from the river, except on its terms. Major Harts concluded:

> It thus appears that the construction of Lock 21 is in the nature of fostering a monopoly or exclusive agreement which prevents fair competition. This is not in the public interest. It is therefore recommended that the appropriation of the $85,000 of additional funds necessary for the completion of this lock and dam when made be expressly coupled with a contingent requirement that before its expenditure an ample, suitable, public free landing place be provided, without expense to the United States, within a reasonable distance of the town of Burnside, with ample and suitable right of way to the streets and roads of the town, to be dedicated to the public use at all time (Annual Report of the Chief of Engineers 1909: 1683).

Between July 1909 and June 1910 operations at Locks A, No.1 and No. 2 were pretty much confined to normal maintenance of, and minor repairs to, equipment and buildings. At Lock No. 3 the broken lower slope of the dam and the apron were replaced with 1,118 cubic yards of concrete. In addition, 100 cubic yards of stone were placed on the bank below the lock and the joints in the paving on the terreplein were filled with cement mortar. Over the next several months the dams at Locks 4, 5 and 6 would be completed and the locks put into operation (Annual Report of the Chief of Engineers 1910: 1856).

The completed dam at Lock No. 4 measured 454.6 feet long and was built at a total cost of $32,125.21. Five hundred twenty thousand one hundred thirty-seven feet, board measure, of lumber had been used in the construction. Stone placed in the dam equaled 4,363 cubic yards, solid measurement, while 828 cubic yards of stone were placed above the dam for backing. The plates for the crest of the dam at Lock No. 3 came at no cost, they had been saved from the repairs at Lock A. Other activities included the construction of two lock houses, at an average cost of $2,687.14 each, and a blacksmith shop for $210. Heavy riprap was quarried and placed on the bank below the lock and abutment and the terreplein was paved with concrete (Annual Report of the Chief of Engineers 1910: 1850).

The working force at Lock No. 5 was also engaged in completing the dam and putting the lock into operation. When finished, contained 705,792 feet, board measure, of timber. The dam, 3,493 cubic yards of stone had been quarried for filling, 775 cubic yards of stone had been quarried and 5,000 cubic yards of gravel had been dredged and placed as backing to the dam. The total cost came to $49,085.77. By the end of June 1910 Lock No. 5 was operational. Construction had begun on the lock houses and seventy-five per cent of their masonry was complete and they were expected to be completed in the next few months (Annual Report of the Chief of Engineers 1910: 1850).

Almost identical construction activities took place at Locks Nos. 6 and 7 over the next year. The lock gates at both were erected by the end of October 1909. Over the next several months, fifty-foot cofferdams were built at the lower end of each lock and the guard walls were finished. At each, a portion of a decaying timber crib at the lower end of the abutment was replaced with concrete, 464 cubic yards being used at Lock 6 and 485 cubic yards at Lock 7. At Lock No. 6,

12,250 cubic yards of sand and gravel were dredged from the dam site and 9,350 cubic yards of stone quarried for the fill of the dam. Nine thousand four hundred fifty cubic yards of stripping were taken off the quarry and 6,449 cubic yards, solid measurement, of stone was quarried at Lock No. 7. Seven thousand two hundred forty cubic yards of sand and gravel were dredged from the dam site. By the close of the fiscal year 481,135 feet, board measure, of lumber for the dam at Lock 6 and 314,500 feet, board measure, of lumber for the dam at Lock 7 had been delivered under contract with T. H. Johnston & Co. of Birmingham, Alabama (Annual Report of the Chief of Engineers 1910: 1850-1851).

Work was still progressing somewhat slowly at Lock No. 21, due mostly to unfavorable weather conditions that had seriously delayed the work at the site, although a shortage of labor was also partly responsible. At the close of the fiscal year, June 30, 1910, the lock and guide walls, with the necessary excavation and embankment, had been completed and the abutment of the dam was very nearly done. The toe wall below the abutment was also complete and construction of the cofferdam had begun. The work of grading the bank for riprapping was three-quarters finished and about a third of the riprap and stone filling for the bank had been installed. The lockmaster's house had been completed at a cost of about $4,700, and the construction of the lockman's dwelling was nearing completion. Work on a brick storehouse was underway. Work on building the dam, however, was just beginning. The District Engineer estimated that about sixty-five per cent of the work necessary at Lock 21 was complete (Annual Report of the Chief of Engineers 1910: 1851-1852; Butler 1910).

By the close of June 1910 it had already become apparent that the lock walls on all of the locks, with the exception of No. 5, would have to be modified. Steamboat operators had complained that boats were experiencing delays when the lock walls were submerged and when the fall was too great to permit the safe passage of boats over the dam. District Engineer Major William Harts stated: "Experience with the locks already in operation indicates that in the course of the next two years it will be necessary to raise the lock walls from 3 to 5 feet, except at Lock 5, where nothing will be required. After the completion of Locks 6 and 7 more definite information as to just what will be necessary will be available and the subject will be more fully considered hereafter" (Annual Report of the Chief of Engineers 1910: 1853). (Annual Report of the Chief of Engineers 1910: 1853; Butler 1917: 3).

Figure 14: Lock master house at Lock 5 today, tile roof has been removed.

By the close of June 1911 all of the locks on the Upper Cumberland, with the exception of Lock 21, were fully operational. The dam at Lock No. 5 had been completed the previous year and the

lock put into operation. Over the next few months the work force at the lock completed two stone houses with red tile roofs for the use of the lockmaster and lockman. A blacksmith shop was also constructed, at a cost of $139.40. The bank below the abutment was riprapped, stone was quarried, prepared and delivered to Locks Nos. 3 and 4 for building roads from the terreplein to the top of the bank and a similar road of stone blocks was constructed at Lock 5 (Annual Report of the Chief of Engineers 1911: 2027-2028).

When completed, the dam at Lock No. 6 cost of $36,203.05, which included use and deterioration of the plant. The finished dam was 402 feet long, 22 feet high and 40 feet wide at the base. The unit cost per linear foot came to $90.05. It was built in pool water (caused by the dam at Lock No. 5) having an average depth of about ten feet at pool level. Five hundred fifteen thousand two hundred forty feet of long-leaf yellow-pine lumber was used in the construction of the timber cribs; which were filled with 4,390 cubic yards, solid measure, of rock. Another 6,149 cubic yards of stone was placed on the bank below the abutment for protection against wave wash (Annual Report of the Chief of Engineers 1911: 2028).

The dam at Lock No. 7 was much the same in size and cost. It was 416 feet long, 22 feet 5 inches high with a base 40 feet wide. The average depth at low water where the dam stood was nine feet five inches. It was built at an average cost of $85.47 per linear foot for a total cost, including use and wear of the plant, of $35,972.18. The construction of the timber cribs consumed 553,103 feet, board measure, long-leaf yellow pine. The cost of framing and placing the cribs was $3,857.77. The cribs were filled with just over 5,351 cubic yards, solid measurement, of rock fill. Over 8,000 cubic yards of rock and gravel backing were placed above the dam (Annual Report of the Chief of Engineers 1911: 2028).

Almost as soon as the first dams were completed complaints began to come into the District Engineer's office. The citizens of Wilson County, Tennessee complained that a ford in a county road was now impassable for more of the year than prior to the construction of Dam No. 3. Several landowners complained of bottomland being inundated from the construction of Dams 6 and 7. It was just the beginning of years of complaints and subsequent litigation (Annual report of the Chief of Engineers 1911: 2031).

Lock No 21 was still coming along slowly. The previous year it had been estimated as about sixty-five per cent complete. Twelve months later it was still only about eighty per cent complete. Minor construction included the completion of the lockman's house, for a total cost of $3,700 and a brick storehouse. Several major components were also completed. A 507 linear foot concrete toe wall below the abutment, including excavation, back filling and grading, was complete; as was a concrete guard wall. The terreplein behind the lock was partially riprapped and the lock chamber unwatered, cleared of debris and damaged cement in preparation for the erection of the steel lock gates" (Annual Report of the Chief of Engineers 1911: 2028-2029; Butler 1911: 2-3).

During the year, Sections I and II of the earth-filled cofferdams for the permanent concrete dam were also built. The dam at Lock No. 21 was the first concrete dam constructed on the Cumberland, as such somewhat different technology and procedures were used than those for constructing a timber crib dam. The progress reports prepared by Junior Engineer John Butler

described several innovations used at Lock No. 21 which the District Engineer included in his yearly report. One successful strategy was a new design used in the construction of the cofferdams, as the District Engineer reported: ". . . these earth-filled dams have proven very satisfactory. A successful detail of this work was the use of a line of sand bags along the toe of the sheeting, thus preventing the earth filling from being cut out by the strong water currents. Another essential detail was the use of tight wooden washers on the tie-rods through the dam, preventing the water from following along the rod and causing leakage. The earth filling in the dams was covered with broken stone filling and 12 inches of riprap, carefully placed" (Annual Report of the Chief of Engineers 1911: 2028-2029; Butler 1911: 2-3).

The rock excavation in the two finished sections of sections of the cofferdam was completed and forms for the concrete dam were built and placed in the cofferdam: "These forms were built in panels, generally about 5 by 10 feet, old lumber being used for making them. The forms for the downstream face of the dam were suspended from 8 by 8 inch posts by 5/8-inch rods and adjusted by turnbuckles. This novel style of forms has proven economical and very satisfactory" (Annual Report of the Chief of Engineers 1911: 2029). Once the forms were completed they were filled with concrete: "Two one-half cubic yard Ransome mixers were used for the concrete, one for each section of the dam. Each mixer can turn out 120 cubic yards of concrete per eight hours, provided the material can be furnished and forms prepared in advance. For fear that cement may run short, "one-man stone" are being embedded in the concrete to the extent of probably 20 per cent. This, besides saving the cement and otherwise being more economical, increases the unit weight of the concrete" (Annual Report of the Chief of Engineers 1911: 2029; Butler 1911).

When the decision had been made in 1906 to concentrate improvement efforts on the Lower Cumberland a survey had been ordered to identify the most favorable sites for Locks B through F (Lock G, initially included in the plan, had been deemed unnecessary). The survey had proceeded as weather, water levels and sporadic funding permitted and was completed in 1909. As sites were approved efforts began to acquire title to the necessary lands. By 1912 the lock and abutment sites for Locks B, C, D, and F had been acquired. Lock E lacked only one parcel to be complete and proceedings were underway to acquire that parcel through condemnation. Contracts for the construction of the concrete lock and guide walls, part of the metal work, construction of the cofferdams, construction of the inspector's house, and much of the excavation for the lock and foundation for Locks B and C were let to Mansfield Engineering Co. and preparatory work began. The sites were cleared and construction begun on temporary quarters for the inspectors (Annual Report of the Chief of Engineers 1912: 2231).

Work at the locks already in operation was relatively minor. Some repairs were made, riprap placed and preparations begun to raise the walls of Lock No. 2. The bank below the lock at Lock A was riprapped, using 10,543 cubic yards of stone. The work of riprapping the banks at Lock No. 2, which had begun in November the year before, was completed. Preparatory work for raising the walls of the lock was begun and consisted of erecting derricks, readying machinery and unloading 720 cubic yards of gravel and 370 cubic yards of sand. Repairs to Lock No. 4 were carried out in September 1911 and necessitated placing 200 cubic yards of concrete in the apron of the lock. A concrete gauge was also erected. At Lock No. 6 the majority of the work consisted of placing 4,301 cubic yards of riprap on the bank below the abutment. A 190-foot

long retaining wall was also constructed and a path along the bank was excavated into the rock along the bluff leading to the upper approach of the lock. Riprap was also quarried and placed on the bank below Lock No. 7, where all work was completed by November 17, 1911 (Annual Report of the Chief of Engineers 1912: 2233, 2236-2237).

Lock No. 21 was placed in operation in October 1911. The solid concrete dam, when completed, was 340 feet long with an ogee face on the downstream side and a 20-foot concrete apron. The total cost was $51,117.63. Once the dam was completed work consisted of quarrying, tramming, boating and placing 545 cubic yards of random riprap, painting the lock houses and improving the grounds. All of the work at the site was completed in August 1912 (Annual Report of the Chief of Engineers 1912: 2233; Annual Report of the Chief of Engineers 1913: 2479).

Now that major construction on the Upper Cumberland was completed attention, shifted to the Lower Cumberland. At Lock A, which had been in operation for several years, work was confined to riprapping the bank below the lock, a task that seemed to be repeated yearly. Construction continued at Locks B and C where the temporary quarters for the work force and the inspectors' house were finished. Although "high and rather unusual" spring floods caused considerable delay, materials were delivered to the sites and the sheet steel piling for the upper guard wall was put in place at both locks. Work also began at Lock D where both the inspectors' house and the temporary quarters for the work force were completed. Work on the cofferdam was started and was well advanced by June 1913. Plans for the abutments, bank protection and dams for all three sites were in preparation (Annual Report of the Chief of Engineers 1913: 2476, 2483).

Work on the Upper Cumberland was generally restricted to maintenance and minor construction. Raising the walls at Lock 2 was completed, a considerable process in terms of both materials and cost. Over 1,639 cubic yards of masonry, 793 yards of which were stone, was placed in the walls at a total cost of $49,136.46. The work force at Lock 2 was also engaged in quarrying over 13,000 cubic yards of stone, solid measure, for riprap and for dimension stone to be used in raising the walls at Lock No. 3. Once the walls were completed at Lock No. 2 part of the labor force and the necessary machinery was moved to Lock No. 3. At Lock 3 a large slide had to be removed and 350 feet of stone-filled timber cribs put in place to hold the bank. The space behind the cribs was filled with 4,150 cubic yards of earth taken from the embankment, all of which was then graded and riprapped. At Lock Nos. 6 and 7, work was of a minor nature. The foundations of two lock tenders' houses was laid at Lock 6 and the labor force quarried stone for riprap. Two lock tenders' houses were completed at Lock 7, at a cost of $6,706.94 (Annual Report of the Chief of Engineers 1913: 2479, 2482-2483).

By mid-summer 1914 work on the locks below Nashville was progressing rapidly. The upper guide wall had been completed and the cofferdam built at Lock B; and a large part of the excavation for the lock walls had been made. The head walls to the lock were completed and the work on the river and land walls was well advanced. Progress was a bit slower at Lock C because of the problems encountered in preparing the foundation for the upper guide wall. Large crevices in the underlying rock made it necessary to go down as far as twenty to twenty-five feet below the water to reach suitable rock. But the foundation for the guide wall had eventually been completed and construction begun on the wall itself. The main cofferdam had been completed

and a large amount of earth had been excavated in preparation of the foundation of the lock walls. At the end of June 1914 concrete was being placed in the river wall of the lock (Annual Report of the Chief of Engineers 1914: 2543-2544).

Work at Lock D, located directly under the bluff beneath Civil War Fort Donelson, was also progressing in a satisfactory manner. Contractor Foster-Creighton-Gould Co., of Nashville was to construct the concrete guide walls, the guard walls, the embankment behind the land walls, the inspector's house and the excavation of the lower approach. By mid-summer 1914 the cofferdam had been completed, as had the excavation for the lock walls. The upper guide wall was complete the upper guard walls and lock walls were nearing completion, and work was being continued on the lower approach excavation and the construction of the lower guide wall. Plans were already underway to receive bids for the abutment, dam and bank protection, but the contract could not be made until after the passage of the pending river and harbor bill (Annual Report of the Chief of Engineers 1914: 2544-2435; Butler 1916: 3).

Great care was taken in the construction of the cofferdam at Lock D. Before any of the cribs were placed soundings were taken from boats and a sketch was made of the bottom where the corner of each crib would rest. From this information a continuous sketch the amount of blocking necessary to make the crib level when it rested on the bottom was determined. Construction of the cofferdam started on June 5, 1914 when the first crib of the upper bank corner was placed and filled with stone. Several cribs were constructed together, the connections being made while that part of the crib was out of the water. As timbers were added, forcing the cribs to the bottom, they were pushed further out into the river where the water was deeper. When they were thought to be high enough to be floated into place without any of them hanging on the bottom they would be put into position next to those previously set, lined up with an instrument and weighted down with stone until they rested on the bottom. The remainder of the timbers necessary to bring the cribs to the proper elevation would be floated on, the tops leveled, and the section connected to the one previously set (Pafford 1917: 4-6).

The cribs were filled with stone excavated from the land wall of the lock, which had been stockpiled for that purpose. After the stone filling in the cribs was above the surface of the water an effort was made to make it as compact as possible. Two men were detailed to place the stone by hand as it was dumped from the wheelbarrows. Great care was exercised in putting the sheeting in the puddle compartment. When the depth of water permitted, the carpenters would examine the bottom, which was practically all rock, with their bare feet so that the proper slope of the bottom could be determined. If that was not possible careful soundings were made. Just prior to nailing the plank was sharpened and struck several blows to the end to broom the bottom to secure a closer joint between the sheeting and the rock bottom. The joint was sealed by placing a continuous line of cement bags, half-filled with sand, along each side of the puddle compartment, before placing the clay puddle. Almost all of the bags were placed by a diver, who worked as a carpenter when not "in the diving suit" (Pafford 1917: 4-6).

The clay for the puddle was secured from a site a short distance away and hauled to the site on barges. The barges were unloaded by a derrickboat equipped with a one-half yard clamshell bucket. As the clay was being unloaded it was kept wet with a continuous stream of water. In addition, men were kept puddling the clay with their feet while it was being placed. After the

puddle had dried for a few days it was covered with twelve to eighteen inches of riprap, consisting mainly of one-man stone set on edge, the interstices filled with spalls and smaller stone. The cofferdam was finished and pumped out on July 31. Later, the design of the dam, the quality of its construction and the efficiency of the contractors in its building were held up as examples of superior work (Butler, 1917: 3; Pafford 1917: 4-6).

Figure 15: Working in the stone yard at Lock 4 in 1914.

While work proceeded more or less satisfactorily on the Lower Cumberland, above Nashville the task of raising the walls at Locks Nos. 3, 4, 6 and 7 continued. Stone was quarried at Lock No. 2 both for riprap at Locks Nos. 3, 4, 6, and 7, and for dimension stone for raising the walls at the same locks. At Lock No. 3 riprap was placed on the bank and below both the lock and the abutment. Prior to raising the lock walls the old coping was removed except at the gate anchorages. New masonry was then added to raise the walls four feet, ten inches, making a net increase of three feet in the height of the walls. Raising the lock walls involved numerous steps. First the rock was quarried at Lock 2, cut, loaded and boated to Lock 3 where it was unloaded. The masonry was then set in place and concrete backing was placed along the new wall. The old coping was raised and dressed and new coping purchased. The lock gates and the guard walls also had to be raised. The total expenditure, including erection of the plant and repairs, replacing the necessary paving, and replacing the valve mechanisms, irons and other miscellaneous work, came to $24,453.83. The work was completed in January 1914 (Annual Report of the Chief of Engineers 1914: 2552).

The work force at Lock No. 3 was moved to Lock No. 4 in January, after completing the work at Lock 3, for the purpose of raising the lock walls, guard wall and lock gates and to cut the stone for raising the walls at Locks Nos. 6 and 7. On the bank below the abutment 2,537 cubic yards of riprap was placed, a little more than one-half being quarried at Lock 2 and the remainder being quarried at Lock 6. The work of raising the walls at Lock 4 was begun. As at Lock No. 3, the old coping was removed and reset, except that around the gate anchorages. The lock walls were built up four feet ten inches, making a net increase of three feet in the height of the wall (Annual Report of the Chief of Engineers 1914: 2552-2553).

Because the lock walls did not need to be raised at Lock No. 5 the work was of a minor character, primarily grading the bank below the abutment and placing riprap on the same. The stone used to riprap was quarried at Lock No. 6 and boated to Lock No. 5, a distance of about seventeen and one-half miles. The lock pit was cleaned with a clamshell dredge and anchorage

pins for boatlines were placed in the walls (Annual Report of the Chief of Engineers 1914: 2553).

Much of the labor force at Lock 6 was engaged in quarrying stone to be used as bank protection at Locks 4 and 5 and in quarrying face stone to be used in raising the walls at Locks Nos. 6 and 7. Work on raising the lock walls, guard walls, and lock gates was begun at Lock No. 6. No active work was begun at Lock No. 7 (Annual Report of the Chief of Engineers 1914: 2553-2554).

By mid-summer 1915 all of the concrete work and excavation on Lock B was complete, including the concrete lock, lock walls and guide walls, the upper guide wall, and the cofferdam. All of the concrete walls had been given a wash coat of neat cement grout. The inspector's house was also finished. Work on the concrete abutment was nearing completion. The hired labor force had started grading the banks and was engaged in preparations necessary to carry on the work of building the timber crib dams. Much the same progress had been made at Lock C. By June 30, 1915 the concrete abutment had been completed, and the necessary bank protection had been placed. The upper guide wall and the river wall of the lock were almost completed. The foundation had been laid for a quarter the length of the land wall of the lock at the lower end in spite of several slides that delayed construction. Contracts for the construction and erection of the steel lock gates at both Locks B and C were entered into with Penn Bridge Co. Earlier in the year an emergency contract was entered into with McLeod Lumber Company to supply and deliver the long-leaf yellow pine for the timber crib dams. By mid-June half of the lumber for Dam B and one-quarter of the lumber for Dam C had been delivered and H. P. Gazzam Machine Co. had delivered the sluice-gate operating machinery for both dams (Annual Report of the Chief of Engineers 1915: 2838-2839, 2841).

Figure 16: Construction at Lock B in January 1914.

At Lock D the concrete work of the lock, guard wall and guide walls was complete, as was the embankment behind the lock and the upper guide wall. The embankment behind the lower guide wall was under construction and a portion of the lower approach had been excavated. A new contract was entered into with Mason & Hanger Co. for the construction of the abutment, the back fill behind the abutment, riprap protection for the same, the grading and protection of the river banks above and below the abutment and below the lock, the paving of the terreplein behind the lock and guide walls, the construction of the dam and the installation of the steel lock gates. By the end of June 1915 the lock gates had been erected but alterations were needed to make them fit properly (Annual Report of the Chief of Engineers 1915: 2839-2840).

Since construction had begun at Locks B and C Lock A had been used as a headquarters for the repair and storage of machinery, derricks and other plant and for the construction and repair of the floating plant. Lock A had also become a receiving area for much of the coal, cement, lumber and other materials used in the hired-labor construction work at Locks B and C. These materials were brought in by rail, the tracks of the Tennessee Central Railroad Company having been built across the reservation about 1905, and transported by boat to the construction sites (Annual Report of the Chief of Engineers 1903: 1582; Annual Report of the Chief of Engineers 1904: 2341; Annual Report of the Chief of Engineers 1915: 2839-2840).

A quarry had been established near Lock B, which promised to supply an excellent grade of limestone for constructing the dam. A tram track had been laid connecting the quarry with the dam site about one-half mile away. The stone would be hauled directly to the construction site in 4-yard tramcars pulled by a small steam engine. By late June 1915 stone was being quarried and stored in anticipation of the pending construction. A quarry had also been established near Lock C. The stone here was not as good but was still of a quality suitable for use in the dam and as riprap. Here, too, stone was already being quarried and stockpiled (Annual Report of the Chief of Engineers 1915: 2841-2842).

Plans for Lock F were undergoing further consideration. Authority had been granted for the purpose of looking into the advisability of selecting a different, and more desirable, site for Lock F than that which had been initially selected. The original survey had indicated that a site at the town of Eddyville would be superior to the site that had been chosen, about one and one-quarter mile upstream from Eddyville. Comparative estimates were being prepared to determine if the site of Lock F should be moved, or if the site remained the same, if the lock should be shifted to the abutment site. Even though the final site was now undecided, concrete monuments were erected at the site of Lock F, as they had been at the site of Lock E, marking the boundaries of the U.S. Government property (Annual Report of the Chief of Engineers 1915: 2842).

On the Upper Cumberland construction work on the locks and dams was finally coming to a close. By the close of the fiscal year ending June 30, 1915 the work of raising the walls at Locks Nos. 4, 6 and 7 was completed at a cost of $22,736.79, $25,522.25 and $20,761.17, respectively.

Figure 17: The "temporary" buildings at Lock 3.

In compliance with a Bureau of Fisheries requirement that fishways be installed in all dams on the Cumberland, fishways had been completed at Dams Nos. 4 and 6 and were expected to be completed at the remaining dams in the next few months. The temporary quarters remaining at Locks 3, 4 and 5 were dismantled and taken to Locks B and C where they were rebuilt. The majority of the work on

the upper river involved maintenance. Lock gates were painted, banks riprapped, as they were almost every season, lock chambers were dredged and minor repairs made to valves and gate operating machinery (Annual Report of the Chief of Engineers 1915: 2848-2852).

During the next two years the capricious Cumberland, well known for her unpredictable conduct, caused considerable delays in construction activities on the Lower Cumberland. River conditions in the work season of 1915-1916 were very unfavorable for low-water work, causing considerable setbacks in construction work being carried on by the hired labor work force. Between July and November, the usual low water season, there were five or six rises in the river, from sixteen to forty-four feet in height. During the same time there were only short periods when the river gauge showed less than five feet in height. With these conditions it was impossible to undertake the construction of the dams at Locks B and D (Annual Report of the Chief of Engineers 1916: 2692).

In March 1915 a hired labor force was sent to Lock B to undertake the preparatory work necessary for building the dam and to locate a quarry. This small force occupied quarterboats during the construction of the temporary buildings. Because the lock site was subject to flooding at very high stages of the river the board and batten temporary quarters were constructed on poles, the floors being about ten feet above the ground. The structures themselves were of the same type constructed over the course of the project: "The houses for the temporary quarters were of the ordinary boxed type of framed structure. Rough Pine planking, 1" x 12", placed vertically, was used for siding, the cracks being covered with 1" x 3" strips. It may be interesting to relate that practically all the lumber for framing and siding used in the construction of these houses was obtained by carefully tearing down similar "temporary" quarters that had been built more than twenty years ago and used during the construction of Locks Nos. 4 and 5 on the river above Nashville (Butler 1916: 8). In placing the buildings care was taken not to interfere with the space required by the contractor, who was also working at the site (Annual Report of the Chief of Engineers 1916: 2692-2693, 2696; Butler 1916: 8; Irwin 1916).

Although construction of the dam was delayed by high water the lock and guide walls and the abutment of Lock B were completed by the end of June 1916. The upper lock gates were erected and the erection of the lower gates was in progress. The hired labor force completed the excavation for the dam and was nearly done with grading and riprapping the banks. Work had also begun on the concrete toe wall and concrete guard wall. A quarry, with stone of a very superior quality, had been located about one-half mile from the lock and quarrying began at the end of May. All stone quarried was stockpiled for use in the dam (Annual Report of the Chief of Engineers 1916: 2692-2693, 2696, Butler 1916: 10; Irwin 1916).

Figure 18: Concrete gauge at Lock A.

At Lock C the river wall was completed and the necessary excavation partially completed. Almost one-half of the land wall and one-third of the lower guide wall were also

completed under contract during the year. The hired labor force quarried 13,490 cubic yards of stone from the quarry opened the previous year. Tram tracks were constructed and 11,699 cubic yards of material was removed from the banks in preparation for placing riprap (Annual Report of the Chief of Engineers 1916: 2692-2693, 2696).

Similar progress was made at Lock D where three-quarters of the embankment behind the lower guide wall was completed. All work on the abutment side, with the exception of a small amount of grading and riprapping, had been completed, as had the excavation of the foundation and the preparation of timber for the dam. In addition, the concrete paving back of the lower guide wall and bank protection on the lock side was completed. The upper lock gates, which had been installed the previous year but did not fit properly, were modified by adjusting the shoes on the upper lock gate (Annual Report of the Chief of Engineers 1916: 2692-2693, 2696).

Additional surveying was done at Locks E and F to complete the information needed to draw up final designs and estimates for the locks. Based on information compiled in this and the previous year the decision was made to relocate the site of Lock F to the town of Eddyville, Kentucky. Investigation of the titles was proceeding (Annual Report of the Chief of Engineers 1916: 2698).

Work on the locks and dams already in operation was, for the most part, of a minor nature. New timber miter posts were framed for the upper gates at Locks A, 1 and 5 and installed at Lock No. 5. A fishway was installed at Dam No. 7 and preparations were made for their installation at Dams Nos. 3 and 5. Concrete gauges were constructed at each end of Lock No. 5, from the top of the lock walls to top of the banks. At Lock 3 a well was bored and sewer pipe laid. Maintenance work included painting the lockmen's houses at Locks 1, 2, 5, 6 and 7 and painting the lock gates at Locks 2, 3, 5, and 21 (Annual Report of the Chief of Engineers 1916: 2702-2103).

As stated previously, work during the fall of 1916, like that of 1915, was greatly curtailed by unseasonably high river levels. The river remained high for much of July and August, permitting work for only about three months before rising again in the latter part of December. The winter of 1916-1917 was also unusually severe, with much more snow and colder temperatures than normal. That winter high water persisted until mid-April before the river began to fall again. The weather only compounded the problem of the difficulty of securing materials and the shortage of railroad cars for transporting them (Annual Report of the Chief of Engineers 1917: 2785).

Work at Lock B and on the dam continued as the weather permitted during the season. The lock gates were erected and the concrete guard wall was completed with the exception of the bridge between the lock and the first pier of the guard wall. The concrete toe wall was completed, concrete steps and gauges were constructed, and mooring rings installed. The all-stone windrow and the house mound were also completed and a fence 2,712 feet long was built. The grounds were graded, cleared of rubbish and sodded (Annual Report of the Chief of Engineers 1917: 2788).

Dredging for the dam was done during the summer of 1916 by the Dipper Dredge *Servier*, removing 4,460 cubic yards of material. Timber for the dam had been received by the end of July and had been piled, by hand, on top of the bank on the abutment side of the river. Construction of the dam began September 1. A pattern, the exact size and shape of the cribs, was framed on a

barge and drift bolted at each intersection of the timbers. Before the permanent crib was set in place the "pattern" was towed and placed exactly where the crib was to be placed. Soundings were then made at each intersection of timbers to determine the differences, if any, in the foundation. If the difference was more than an inch blocks were drift bolted onto the bottom of the crib to compensate. By this method all of the cribs were kept level the entire length of the dam. The cribs were built of ten-inch square lumber, thirty feet on the long side and ten feet on the short side. This large 'crib' was then divided with ten-foot stringers to form the standard ten by ten foot compartments. All of the foundation cribs were built on a barge, generally three stringers high, drift-bolted and launched into the river. They were then put in place and tied to a derrickboat and built up until they were high enough to be just above the level of the water. The cribs were then weighted with solid stone until they sat squarely on the bottom. They were then lined up with a transit and, if satisfactory, were filled with stone to the top of the water. Once the cribs were in place the dam was leveled to a correct elevation. The timberwork was then raised four feet the entire length of the dam. Next the closing crib was built in place, as necessitated by the very strong current. The dam was then filled with stone, leaving thirteen openings. A fishway was constructed and the seven openings left for the flow of river were gradually filled. The vertical sheeting was placed on November 3. The completed dam was 440 feet long, twenty feet high, with a base of sixty feet. In spite of delays caused by the high river level and other problems Dam B, complete with fishway, was finished November 7 and the lock placed into operation November 19, 1916 (Annual Report of the Chief of Engineers 1917: 2788; Irwin 1916).

In describing the contract work at Lock C for the fiscal year ending June 30, 1917 the District Engineer reported: "During the fiscal year the earth excavation, the rock excavation, the concrete work, handling and placing iron, puddling, and bolt holes were completed. A steel pile core wall was driven in prolongation of the upper wing wall of the lock . . ." (Annual Report of the Chief of Engineers 1917: 2785). Part of this work included placing 15,000 cubic yards of embankment back of the land wall. The top and side of the house mound were surfaced for a length of 275 feet. The upper end of the main cofferdam and the sheet steel coffer in front of the upper guide wall were removed. The hired labor force was engaged in riprapping, completing a stone windrow and grading the bank below the lower guide wall. Work continued on the excavation for the guard wall and for the dam. A forty-three foot section of the dam, adjoining the abutment, was constructed to the elevation of the lower slope timber. A number of temporary buildings were constructed that year: a kitchen and dining room, 16 by 60 feet; quarters 16 by 36 feet and a magazine for dynamite were constructed at the quarry. A cement shed, 74 by 17 feet, was constructed at the lock. The hired labor force remained at Lock C until November 16 when it was moved to Lock D to assist in the construction of the dam, remaining there until December 9 (Annual Report of the Chief of Engineers 1917: 2785, 2788-2789).

Work at Lock and Dam D in the fall and early winter of 1917 was a scramble to complete the dam and put the lock into operation before high river levels negated the possibility of further work for the season. The remaining concrete paving and riprap was placed on the back of the lower guide wall. The excavation of the foundation for the dam and preparation of the timber for the dam was completed. On November 16 the hired labor force of 28 men, one derrick boat, two barges and two quarter boats were moved from Lock C to Lock D, at the direction of the district officer, to assist the contractor in completing Dam D. By the time high water set in all had been

completed except placing the derrick stone fill below the dam. An overhead cableway was later obtained from the Louisville district, which was erected at the dam, and all derrick stone filling required below the dam was completed. The hired labor force was responsible for completing the work at the site including the excavation of the lower approach, removing a large quantity of mud from the valve culverts and cleaning and painting the operating machinery. A portion of the cofferdam, left in place by the contractor, was also removed. The dam, with fishway, was completed and Lock D was placed in operation December 21, 1916 (Annual Report of the Chief of Engineers 1917: 2786).

Originally, it was intended to construct Locks E and F by contract. When only bids considered excessive were received for the work at both locks it was decided, in mid-December, to do the work at Lock E with hired labor. The same decision was made on February 9, 1918 regarding the construction of Lock F. Emergency contracts were entered into with Causey Yellow Pine Co. of Hattiesburg, Mississippi to supply and deliver the yellow pine lumber for the cofferdam at Lock E and with Watkins-Gray Lumber Co. of Hattiesburg, Mississippi to supply the lumber for the cofferdam at Lock E. By June 1918 half of the lumber had been delivered at both locks (Annual Report of the Chief of Engineers 1917: 2789-2790, 2796).

The first of the hired labor force reached Lock E on January 20, 1918 and began clearing the grounds for temporary quarters. Five days later the gasoline tender *White Oak* and the dredge *Tishomingo*, with a 3-yard dipper, reached the site, having come from the Tennessee River. High water and bad weather prevented the crew of the *Tishomingo* from accomplishing much until April but by the end of May the *Tishomingo* had removed the greater part of the excavation necessary for the land wall of the lock and the lower guide wall and had cleared a large part of the loose material from the site of the cofferdam (Annual Report of the Chief of Engineers 1917: 2789).

The hired labor force engaged in preparatory work, which included the installation of the plant, for which considerable excavation was necessary, laying tram track and the erection of thirteen temporary frame buildings housing everything from laborers' quarters to offices to explosives. The Annual Report for the fiscal year ending June 30, 1917 lists these structures as follows: ". . . Mechanics' quarters and office, two story, 101 by 21 feet, with a one-story T across front, 32 feet by 21 feet; laborers' quarters and mess hall, 82 by 18 feet; laborers' quarters, 36 by 24 feet; commissary, 20 by 58 feet; magazine, 6 by 8 feet; blacksmith shop, 36 by 18 feet; carpenter shop, 36 by 24 feet; magazine, 8 by 10 feet; tool shed 14 by 18 feet; oil room, 10 by 14 feet; cement house, 48 by 140 feet; quarters, 14 by 30 feet; and quarters 12 by 14 feet; all buildings being one-story, except part of the mechanics' and office building, as stated" (Annual Report of the Chief of Engineers 1917: 2790-2791). The first five buildings were partially constructed with lumber recycled from the old temporary buildings at Lock No. 2. The plant which was installed at the lock site consisted of one wooden derrick; one steel derrick; one haulage engine; one hoisting engine; one water tank with distributing line; 1,100 linear feet of 3-foot track, including 206 linear feet of incline framed trestle; one sawmill; one blacksmith shop and a concrete-mixing plant. Much of the twenty acre lock site was wooded. This timber was cut and the wood stored for fuel. Miscellaneous work at the site included the construction of a 3,000 foot long fence and improvement of the road from Lock E to the Trigg County Road, one-half mile distant (Annual Report of the Chief of Engineers 1917: 2789-2790).

Work began at Lock F when the steamer *John*, with three quarter boats, a barge of lumber and a small work force, reached the lock site on April 16, 1917. High water prevented much permanent work from being done but the small work crew was able to clear the banks, prepare sites for the temporary buildings and do other preliminary work. After May 15 the work force jumped from 28 to 44 men. By the end of June eight temporary buildings had been erected: "a cement house, 24 by 100 feet; storehouse, 20 by 50 feet; blacksmith shop, 18 by 36 feet; mechanics' quarters, 138 by 16 feet; bath and toilet house 7 by 24 feet; laborers' quarters 18 by 82 feet; Negro quarters, 24 by 36 feet and a magazine 8 by 12 feet" (Annual Report of the Chief of Engineers 1917: 2790).

Two derricks were erected for handling materials. On April 28 derrick boat No. 4 arrived and began unloading materials, excavating derrick foundations and assisting in the erection of two more derricks. About 700 feet of tram track were laid. Five barges of miscellaneous plant were received and unloaded and a trestle was constructed for conveying coal from the unloading derrick to the storage bins. Eight hundred feet of water line were laid, connecting the laborers' quarters and boilers with the Eddyville water main. About 200 linear feet of sewer pipe were laid connecting with the State Prison sewer. Other necessary work involved diverting the sewage from the lock site where the main sewer discharged on the riverbank. One of the last items listed among the miscellaneous work was clearing a parcel of land, planting and cultivating a large garden on the reservation (Annual Report of the Chief of Engineers 1917: 2790-2791).

Work at the remaining locks and dams on the Cumberland was confined to repairs, painting and other maintenance of the machinery, structures and locks themselves. Lock A continued to serve as the headquarters for the construction and repair of the floating plant and for the storage of machinery, derricks and other plant, as well as the reception area for much of the materials bring used in the construction of Locks B, C, E, and F (Annual Report of the Chief of Engineers 1917: 2800-2801).

Over the next year frequent rises in river levels and severe weather continued to plague the project on the Lower Cumberland. "Extremely cold weather set in early December. The winter was unusually severe and the cold weather, snow, and ice greatly interfered with all work." Although it was easier to get materials than it had been a few months ago the labor shortage had become acute. The canalization of the lower Cumberland was feeling the effects of World War I. The United States had entered the war the previous spring, on April 4, 1917. Immediately, thousands of young men joined the ranks of the armed forces. In May 1918 Congress passed the Draft Act, making men age 21 to 30 subject to military call. In the summer of 1918 a second draft law was passed, requiring men 18 to 45 to register for possible military service. By the end of June 1918 the labor shortage had had a very real adverse affect on the project. In the annual report, the District Engineer writes, "Great trouble was experienced because of the labor situation, only 20 per cent of the normal force being employed because of the operation of the selective draft law . . ." (Annual Report of the Chief of Engineers 1918: 2840). What men were available for work generally took jobs elsewhere because of the higher wages offered by other employers in the area. "The work was delayed by the shortage of labor. A large number of experienced employees left the work, being attracted by higher wages paid on other work. Although the wage scale on the work was greatly increased, the labor secured was inexperienced

and therefore inefficient" (Annual Report of the Chief of Engineers 1918: 2837). It was a problem which would persist for the next few years (Alden 1963: 683-685; Annual Report of the Chief of Engineers 1918: 2837, 2840).

The concrete lock and guide walls at Lock C were completed in the fall of 1917 and the gates, which had been delivered eighteen months earlier, were finally erected. Work on the dam continued, a total of 150 feet being constructed and filled with 1,410 cubic yards of stone. The bank on the lock side was riprapped, a guard wall constructed and an extension was made to the wing wall of the lower guide wall. The terrepleins back of the lock and lower guard wall and a portion of the terreplein behind the upper guide wall were graded, filled with gravel and stone to a depth of from six inches to three feet, and paved with 3,135 square yards of concrete. During the season 6,100 cubic yards of stone were quarried for the dam, a temporary warehouse and a temporary cement house were constructed and telephone lines were installed (Annual Report of the Chief of Engineers 1918: 2837-2839).

Lock D had been put into operation in December of 1917 and little remained to be done at the site. One frame house was constructed, a handrail placed on the lock wall and eight and one-half acres of the site were "grubbed and cleared of bushes and briars" (Annual Report of the Chief of Engineers 1918: 2839).

Lock E, being constructed by hired labor, felt the labor shortage, and although construction continued, it was slowed. The weather also had its effect, greatly curtailing work between December 1917 and March 1918. In spite of these problems the cofferdam was completed and excavation began. About 200 cubic yards of earth were excavated for the foundations of the land wall and 600 cubic yards from the foundations of the lower miter sill. Over 2,700 cubic yards of rock were excavated from the foundations of the lower miter sill and the adjacent portions of the land and river walls. Portions of the bank were graded and covered with hand-placed riprap and 378 tons of windrow derrick stone. The foundation of the concrete-mixing plant, begun the previous year, was finished and the majority of the plant itself installed as the timber framing continued around it. Seven acres of the site was cleared and two roads were built – one from the lock to the Canton-Linton Road and another that crossed the reservation, giving access to the commissary, tool houses and storage yard. Two houses were begun, one lockmaster's and one lockman's, and a three and one-half mile telephone line was installed, connecting the lock with a line on the Canton-Cadiz Pike. Other work included the framing of four new wooden derricks, erecting ten wooden derricks with engines and boilers, placing 1,000 feet of tram track and repairing another 600 feet and making repairs to the *White Oak* and other of the floating plant (Annual Report of the Chief of Engineers 1918: 2839-2840).

The cofferdam at Lock F was also completed and excavation for the lock and guide walls begun. Over 2,100 cubic yards of rock were removed from the approach and foundation of the lock and 942 cubic feet of earth excavated form the lock and guide wall foundations. Construction began on the upper guide wall, consuming 322 cubic yards of concrete. A total of 104.5 linear feet of test holes were drilled for the anchor holes; and an 875-foot long road to the steamboat and ferry landings was located and graded. A concrete culvert was constructed which required 26 cubic yards of concrete, 400 cubic yards of derrick stone for the foundation and 75 cubic yards of stone placed at either end as protection. A trestle and track, 1,440 feet long, was constructed for

handling clay from the pit to the cofferdam and a track was laid to the top of the bank for moving and storing supplies above the high-water mark. Two buildings, a carpenter shop and a small powder house were built. Miscellaneous work consisted of building a fence around the office, making and setting thirty-three concrete property markers, cutting 173 cords of wood and making repairs to temporary buildings and to derrick boat *No. 4* (Annual Report of the Chief of Engineers 1918: 2840-2841).

The usual work of operating and maintaining the locks already in operation continued. The annual report has the usual list of minor repairs, painting, work done to houses and grounds, snagging and dredging and construction and repair of plant, but one new entry reflects the country's entry into World War I, *Guarding Locks.* This new subheading under *Operating and Care of Locks and Dams on Cumberland River* reads: "Guarding Locks.- At all of the locks an armed guard was maintained for the purpose of protecting locks against possible damage from enemy agents. This work was done by the regular lock-keeping force and one additional employee, designated as a temporary guard" (Annual Report of the Chief of Engineers 1918: 2851-2852).

The labor shortage experienced the previous year continued through the next twelve months: "The work was greatly hampered by reason of the fact that many of the trained and experienced employees left the work to enter military service or accept better positions elsewhere" (Annual Report of the Chief of Engineers 1919: 2915). Weather and river conditions did improve, however, being somewhat better than average. Between July 1 and December 16, 1918, river stages allowed construction to be actively prosecuted (Annual Report of the Chief of Engineers 1919: 2915).

Although Lock B had been placed in operation November 9, 1916 some work still remained to be done at the site. The lockmen's houses had not yet been constructed, some of the bank was still lacking riprap and the grounds had not been improved. However, no work was done at Lock B over the next 18 months (Annual Report of the Chief of Engineers 1919: 2915).

Work at Lock C during the summer of 1918 consisted of paving the lock terreplein with concrete, placing riprap and removing the cofferdam. Major construction at Lock C came to a conclusion August 31 when the dam was finished. The lock was put into operation on September 2, 1918. Miscellaneous work completed during the remainder of the season included backfilling, setting mooring rings in concrete blocks, building 90 linear feet of concrete steps and beginning construction of a fence around the reservation and clearing one acre of ground of timber (Annual Report of the Chief of Engineers 1919: 2915-2916).

Figure 19: Remains of a mooring ring at Lock C.

Lock D had been placed in operation in December 1916 and only minor work was carried out at the site. A concrete cistern was built for

the lock house, the ongoing task of erecting a fence around the reservation continued and 4,960 cubic yards of gravel fill was placed above the dam (Annual Report of the Chief of Engineers 1919: 2916).

Work at both Locks E and F continued to be hampered by a severe shortage of labor. At Lock E it was reported that only about twenty per cent of the proper working force had been obtainable for the work season. Obtaining supplies was no longer mentioned as a problem and during the year 270 cords of wood, 1,800 tons of coal, 40,000 feet, board measure, lumber, 13,310 cubic yards of sand and gravel and 6,665 barrels of cement were received at the site. The cast iron valves and other ironwork for the lock were also received during the year, delivered by the contractor, Nashville Machine Co. of Nashville, Tennessee (Annual Report of the Chief of Engineers 1919: 2916).

Earth and rock totaling 7,560 cubic yards was excavated from within the cofferdam and from the foundation of the upper guide walls and the lock pit at Lock E. Over the course of the working season the cofferdam was unwatered six times, 7,965 square feet of forms was erected, 779 cubic yards of concrete and 2,040 pounds of steel anchor rods were placed in the lock wall and 1,805 cubic yards of concrete and 340 pounds of steel anchor rods were placed in the upper guide wall. The area behind the lock wall and upper guide wall was backfilled and a temporary earthen cofferdam built around the upper guide wall. Almost 3,000 cubic yards of stone was stored for use in the dam, the concrete-mixing plant was completed and two lock houses were constructed during the year (Annual Report of the Chief of Engineers 1919: 2916).

Construction activities at Lock F continued to be curtailed by the labor shortage. Excavation of the lock pit and foundation of the lock walls continued and almost 1,500 cubic yards of concrete was placed in the upper guide wall. Problems were encountered with leakage into the cofferdam and 575 cubic yards of earth and gravel were placed as backing to correct the problem. In the summer of 1919 excavations of the lock proper turned up a problem regarding the foundation rock for the lock that would not be resolved for some months. During the year additional plant was installed on site, including three wooden and one steel derrick. Repairs were made to the floating plant including the dredge *Tishomingo*, quarterboat *No. 21* and to derrick boat *No. 5* (Annual Report of the Chief of Engineers 1919: 2917).

Figure 20: A derrick boat c. 1910.

At the locks already in operation activities during the fiscal year ending June 30, 1919 were confined to care and maintenance. Lock No. 1 was unwatered and thoroughly repaired. At Locks Nos. 2 and 3 new quoin and miter timbers were spliced in on the gates to replace decayed timbers, and so on. At Lock B repairs were begun on the timber apron of the dam that had been partly carried away by previous high-water stages. Surveys were made

at Dams 1, 2, 4, 5, 6, 7, 21 and D to determine the amount of scour that had taken place since their construction. Guards continued to be posted at all locks, with the exception of Lock C, until December 1, 1918. World War I had ended with the signing of the armistice on November 11 (Alden 1963: 695; Annual Report of the Chief of Engineers 1919: 2927-2928).

The favorable working conditions experienced in the fall of 1918 did not last long. The following season was very short, with unusually long and frequent periods of high water, which meant that a great deal of time was lost. The labor shortage continued to be a problem as well. Locks B, C and D were already in operation and work at these sites was minor. Some of the old plant, the temporary buildings and materials were removed from these locks and transferred to Locks A, E and F (Annual Report of the Chief of Engineers 1920: 2575).

During the curtailed work season work accomplished at Lock E was confined to excavation for the lock, during which 13,635 cubic yards of earth and rock were removed and 3,600 cubic yards of concrete were placed. Over 13,000 cubic yards of earth and rock were excavated for the abutment. The concreting plant was installed on the abutment side and a large quantity of sand and gravel pumped and stored for future use. During the high water season a cistern was constructed for one of the lock houses and a number of "improvements of a permanent character in the way of roads and walks" was made to the grounds. In addition, three temporary quarters for the working force were constructed. During the working season the contract for furnishing and erecting the steel lock gates was let for Lock E, to the Nashville Bridge Co. of Nashville, Tennessee for the sum of $28,740.00 (Annual Report of the Chief of Engineers 1920: 2575-2578).

Excavations for the lock proper in the summer of 1919 had turned up a problem at Lock F. The bedrock on which the lock was to rest was not continuous, as had been thought. The rock ledge under the downstream half of the lock proper was not solid but was revealed as a mass of boulders and clay under which no solid rock could be found at any reasonable depth. It was decided that the best course of action might be to shift the lock proper into the area now to be occupied by the lower approach and to concentrate excavations in this area. It was explained as follows: "As the lower approach excavation must be made before the lock can be used, and is largely in rock and requires a cofferdam for its economical removal, it was decided to undertake the work during the working season of 1920 with a view to shifting the location of the lock proper into the lower approach, should a good foundation be found. This change will be economical in both time and money if it is possible to make it, and in the meanwhile excavation at the present site will be continued, as this will be necessary should the lock be completed there, or if the lock is shifted it will be necessary for the upper approach in the new location" (Annual Report of the Chief of Engineers 1920: 2576-2577).

As at Lock E, the work season was greatly shortened by unusually high river levels. The cofferdams flooded on October 14, prohibiting work in the river. Until that time excavation on the lock and backfilling were about the only construction activities accomplished. Some work was undertaken to establish a new steamboat and ferry landing for the town of Eddyville. Lock E would destroy the utility of the current landing and conditions imposed when the site for Lock F was purchased required that a new landing be provided (Annual Report of the Chief of Engineers 1920: 2576-2577).

The River and Harbor Act of March 2, 1919 made provision for the construction of Locks and Dams Nos. 8 through 17 on the Upper Cumberland, reviving the project which had been halted in 1906 when attention was directed toward improvements on the lower river, at the expense of those originally planned for the river above Nashville (Annual Report of the Chief of Engineers 1921: 1287).

The construction of Locks and Dams Nos. 8-17 was " . . . subject to the conditions precedent that local interests bind themselves to protect the United States against all claims for damages due to overflow, and to provide sufficient areas of water front and suitable water terminals at all towns and landings adequate for the traffic, and which shall be open to the pubic equally and on terms satisfactory to the Secretary of War" (Annual Report of the Chief of Engineers 1921: 1288). Negotiations had begun with the municipalities and counties affected by the construction to secure compliance with these conditions. The three counties in Tennessee had submitted guarantees of compliance that had been accepted by the Secretary of War on December 4, 1919, but those in Kentucky had not. Nonetheless, the river and harbor act of 1920 authorized work to proceed without waiting for the action of local interests in Kentucky (Annual Report of the Chief of Engineers 1921: 1287).

Active work at Lock 8 was renewed during the summer of 1920 when investigations of foundation conditions, interrupted fifteen years ago, were resumed. Part of the land necessary for the lock reservation was purchased, and negotiations continued on the remaining lands on the lock side. Land for the dam abutment had been purchased in 1899, before improvements to the Upper Cumberland had ceased. During the work season preparation of the site began. Temporary buildings were put up and work on the cofferdam was begun. Excavation of earth at the lock sites was almost ninety per cent complete by the end of the season. A quarry was also opened and about ten percent of the stone estimated to be needed for the lock and dam was quarried and stored. Between April and the end of July 1921 a debate over the final design for Lock No. 8 threatened to seriously slow construction, but the plans originally submitted were finally approved by the Chief of Engineers and work continued with out delay. As well as work at Lock No. 8 was progressing it was in danger of coming to a standstill in a year's time. Lack of funding, a problem that had plagued the projects on both the Upper and Lower Cumberland since their inception, was once more an issue. In the annual report dated June 30, 1921 it was estimated that if no further appropriations were forthcoming all of the funds available would be expended by June 30, 1922 (Annual Report of the Chief of Engineers 1921: 1287, 1289; Correspondence regarding the design of Lock No. 8, Cumberland River, April 16 – July 28, 1921).

Survey to locate sites for Locks Nos. 9 and 10 was also resumed in the summer of 1921. By the following June suitable sites had been found and preliminary work was underway to locate a site for Lock No. 11.

On the Lower Cumberland work was again progressing at a satisfactory pace. No mention is made in the annual report of labor shortages or poor weather and river conditions for the year ending June 30, 1922. By the end of June 1921 the rock excavation for the lock chamber and lock walls was completed for Lock E and the concreting was completed in the lock proper.

Backfilling behind the wall was finished shortly afterward. Excavation for the abutment was almost finished and almost a third of the foundation completed. Excavation began for the lower guide wall and by mid-summer was seventy-five per cent complete. Excavation of the lower approach was also begun and the lock gates were delivered. During the work season some minor improvements were made to the house and grounds. A number of construction materials were received and a large quantity of sand and gravel was pumped and stored (Annual Report of the Chief of Engineers 1921: 1280).

The decision had been made to shift the position of Lock F downstream. A new cofferdam was built downstream of, and adjoining, the old cofferdam. Excavation was begun in the new cofferdam and by June 1921 was three-quarters complete (Annual Report of the Chief of Engineers 1921: 1280-1281).

During the working season of 1921-1922 the lower guide wall at Lock E was completed, with the exception of a short wing wall. Excavation of the lower approach and the work of grading the bank on the lock side below the lock lacked only a small amount of work to be complete. By the end of the season the abutment was more than half complete as was grading and paving of the bank on the abutment side. The steel lock gates, which had been delivered the previous year, were erected. Lock E was moving steadily toward completion. Lock F was also progressing. Rock excavation in the lock pit was completed during the work season and concreting the lock was almost one-half complete. Earth excavation had begun on the abutment. A quarry was opened near the site and almost one-third of the stone necessary to complete the lock and dam was quarried and stored (Annual Report of the Chief of Engineers 1922: 1300-1301).

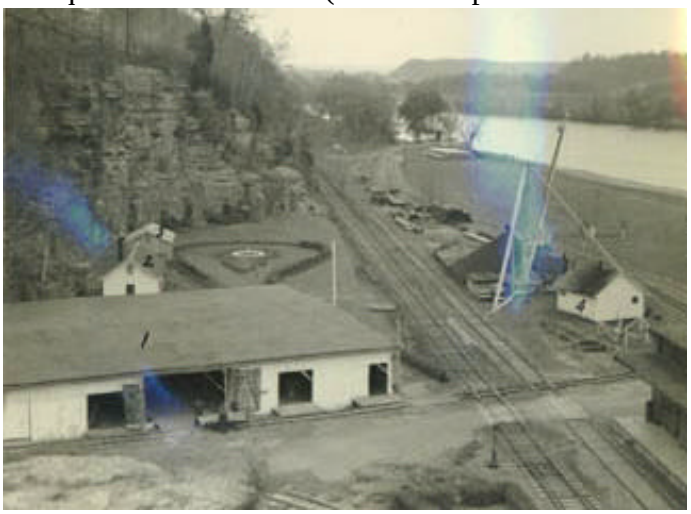


Figure 21: The facilities at Lock A in 1939.

At Lock No. 8, on the Upper Cumberland, preparations continued and construction activities commenced. An additional 8.35 acres of land was purchased for the site of the employee quarters and temporary quarters and other buildings were erected. Machinery and equipment were purchased and installed. The cofferdam was finished and excavation of the lock pit begun. By the close of the season eighty per cent of the necessary earth and rock excavation in the lock pit had been completed. Unfortunately, the funds that had been appropriated for Lock No. 8 were quickly being depleted. In the Annual Report dated June 30, 1922 it was estimated that the $58,955.15 on hand would have been expended by September 1, 1922. Funding, in the amount of $535,000, was strongly recommended to see the project to completion (Annual Report of the Chief of Engineers 1922: 1307).

Since construction of Locks and Dams B-F on the Lower Cumberland had commenced Lock A had served as a receiving station for supplies, a repair facility for machinery and as a boatyard for maintenance and repair of the floating plant. In order to improve the facilities at Lock A necessary for these activities a temporary building for storing cement and a storage shed for lumber were erected during the work season of 1921-1922. The following year construction began on a permanent warehouse. During that same time, Lock No. 2 was being prepared to serve the Upper Cumberland in much the same fashion as Lock A. Before June 30, 1922 a little over eight acres was purchased on which a boat yard was to be constructed and a warehouse, set on a foundation and having a concrete floor, was constructed. Activities at the remaining locks in operation were confined to maintenance and repair. The lock houses, two each at Locks B and C and one at Lock D, still had not been constructed, leaving those projects technically uncompleted. The following year a lockmaster's house and a cistern would be built at Lock B and a lockmaster's house at Lock C, bringing both projects closer to completion (Annual Report of the Chief of Engineers 1921: 1281, 1291; Annual Report of the Chief of Engineers 1922: 1312; Annual Report of the Chief of Engineers 1923: 1172).

During the fall of 1922 the abutment at Lock E was completed and the dam begun and completed in the space of a few months. The District Engineer, Lieut. Col. J. R. Slattery, provides a very complete description of the construction of the dam, which in many ways is typical of all of the timber crib dams placed on the river, allowing for advances in technology and materials, such a steel sheet piling replacing wood sheathing, between the construction of the first dams at Lock A and No. 1 and this dam, which was one of the last:

> A trench was first excavated in the bed of the river, so as to provide a level bed for the entire width of the river on which to base the dam. It was expected that this material would consist of fairly loose gravel; but it was found to consist partly of loose gravel, but principally of cemented gravel, which it was practically impossible to handle except with a dipper dredge. Considerable time was lost and unnecessary expense incurred as a result of delays incident to replacing the derrick boats equipped with clam-shell buckets (which proved unable to handle the material) with a dipper dredge. It was necessary to wait for a rise in the river before a dipper dredge could be gotten to the work. A total of 8,899 cubic yards of material was dredged in preparing this trench. Part of the material was simply thrown to one side, and part of it was placed on decked barges, which were towed some distance downstream, where the material was removed by means of a derrick boat operating a clam-shell bucket. The cost of this excavation amounted to 38-1/2 cents per cubic yard.
>
> Long left (sic) yellow pine and Douglas Fir were used in constructing the cribs – 341,402 feet b. m. of he former and 356,389 ft. b. m. of the latter. The average price of this timber was $49.83 per 1,000 ft. b. m., delivered at Kuttawa, Ky., some 25 miles below the site of the dam, the nearest point at which railroad tracks come close to the river. From this point the timber was placed on decked barges and towed to Lock E, where it was unloaded on the bank, part being placed near the upstream end of the lock within reach of a derrick with a 90-foot boom, and the balance in a yard a short distance below the lock, from which yard it was hauled to the derrick aforementioned by narrow gauge railroad.
>
> This derrick handled the timbers from the bank to hinged ways built on a barge . . . The cribs were 30 ft. x 48 ft. 9 in., with pens approximately 10 ft. x 10 ft. The cribs were first built up to a height of 6 timbers; then one end of the hinged ways was lifted by a derrick, causing the crib to slide into the water. The cribs were then towed into position and sunk by laying on them steel

sheet piles, to be driven later immediately upstream from the dam to cut off the flow of water underneath the same. The cribs were carefully lined up by transit on the shore and were carefully adjusted and held in proper vertical position by being secured to 3 inch x 12 inch uprights resting on the bottom. As soon as the cribs were correctly aligned and leveled, sufficient one-man stone was placed in the pens to hold the partially completed cribs securely in position. The cribs were then built up to the height of the apron, and all of the pens were filled, except three in each crib were left open in order to care for the flow of the river. The decking of the apron was then placed and the sheet piling driven along the upper side of the dam. The first crib was placed near the center of the stream, the excavation of the trench not having been completed immediately adjoining the abutment. From this crib, cribs were placed in each direction, until the dam was completed to the height of the apron from the abutment to within about 150 feet of the lock. This gap was left open to care for the flow of the river in case completion of the dam should be prevented by high water. Work was then started immediately next to the abutment, bringing the cribs to full height and filling all of the pens, except three in each crib left open to care for the flow of the river. When this work had progressed to such a point that is was felt reasonably certain that the remainder of the dam could be placed within two weeks, cribs were placed closing the gap and work was started placing the decking and sheathing, starting from the abutment side.

The final step was to fill the pens left open, and place the decking and sheathing over and above these pens. Derrick stone was placed along the toe of the dam as soon as possible after cribs were sunk and completed to a height of the apron. After completion of the dam additional derrick stone was placed below that previously placed, and likewise along the abutment. The rock used for filling the cribs and for protecting the toe of the dam and abutment was excavated from the lock pit and stored on the bank just below the lock. When needed for filling the cribs it was loaded into skips by hand. These skips were lifted and dumped into dump cars by means of a derrick, and the dump cars were then run down a track extending down the river bank and dumped on decked barges. A small quantity of the rock was loaded directly into dump cars by means of a Thew shovel, and a small quantity of the rock was obtained from loose rock in a quarry a short distance below the site of the lock. . . The loaded barges were towed to the dam, a distance of only about 200 yards. The rock was then loaded by hand into skips, which were placed picked up by derrick boats and dumped into the pens. Three derrick boats were used on the job.

In order to drive the sheet steel piling, a standard gauge track was built across the dam when it had been completed to the height of the apron, and a traveling pile driver mounted on the tracks and equipped with a steam hammer, was used in driving the sheet steel piling.

It is thought that this method of handling of handling the rock for use in this dam was excessive. In building the dam at Lock F, it is proposed to quarry the necessary rock during the winter (1922-23) and store the same on the bank immediately above the abutment. From this storage pile it is proposed to run a track down the bank and out over the dam. The track will probably be placed (Slattery 1923).

When completed, Dam E was 450 feet long and had been built for a cost of $105,213.80. After Lock E was placed in operation November 20, 1922 only minor work remained: backfilling above the dam, placing about 100 cubic yards of concrete in the upper guard wall, cleaning up the site and a few other items. During the same work season the abutment at Lock F was begun and completed and about 99,360 cubic yards of earth was excavated in aligning and grading the bank at and near the abutment. Concreting of the lock walls was nearing completion, with work

left only on the lower guide wall and upper guard wall, both of which were partially complete. A contract had been let for the steel lock gates and the gates had been fabricated and delivered to the site, though they had not been erected. The timber for the dam was purchased and stored and about fifty per cent of the rock necessary for the dam had been quarried and was stored near the site (Annual Report of the Chief of Engineers 1923: 1161-1162).

Between July 1 and September 1, 1922 the lock walls had been brought to a height of twenty feet, but construction at Lock No. 8 was at a standstill for most of the work season. As predicted the year before the funds available were exhausted early in the work season and active work was suspended on September 1, 1922. Some funds were forthcoming the next year and work was able to resume in May 1923 but the stoppage had been costly: " Much time was lost and additional expense occasioned by this suspension, because of the necessity of reorganizing a working force and reassembling plant" (Annual Report of the Chief of Engineers 1923: 1168). As it was, it was estimated that the funds now available would be exhausted once more by June 30, 1924 (Annual Report of the Chief of Engineers 1923: 1168-1169).

When the work season began on July 1, 1923 little remained to be done at Lock E, which had been put into operation November 20, 1922. During the year the guard wall was completed and 2,211 cubic yards, solid measurement, of derrick stone were placed along the abutment and the apron of the dam. The latter measure was "made necessary by reason of the scour occurring in the gravel river bottom adjacent to the dam and abutment" (Annual Report of the Chief of Engineers 1924: 1162). At Lock F the concrete work on the lock was completed, with the exception of about 300 cubic yards of the lower wing wall. The dam was begun, and finished, between July 1 and the end of October. Grading and riprapping on the banks above the abutment side was completed and backfilling of the lock and paving the terreplein was begun. The lock gates, delivered the previous year, were erected. By the end of October enough had been finished to render the lock functional and on November 1, 1923 Lock F was placed in operation (Annual Report of the Chief of Engineers 1924: 1163).

Work at Lock No. 8, which resumed in May 1923, continued into the new work season. A contract for the steel lock gates was let and the gates delivered. Concreting the lock walls was completed, as was the abutment. Timber for the dam was secured and delivered to the site and stone was quarried for dam fill. The tremendous task of excavating, grading and riprapping of the banks was begun. By the close of the fiscal year, June 30, 1924 Lock and Dam was seventy-one per cent complete (Annual Report of the Chief of Engineers 1924: 1169).

Minor improvements continued to be made at the locks already in operation. On the Lower Cumberland a 3-foot gauge track system between the railroad siding and the riverbank, which had been started the previous year, was completed at Lock A. The cistern at Lock B and the lockmaster's house at Lock C, also begun the previous year, were finished. At Lock 1 on the Upper Cumberland, the old timber-crib guard wall was replaced by a concrete wall (Annual Report of the Chief of Engineers 1924: 1173).

Between July 1, 1923 and June 30, 1924 preliminary surveys were made for proposed Locks and Dams Nos. 12 and 15. It would be the last such survey of the current Upper Cumberland improvement project. On March 6, 1924 the Committee on Rivers and Harbors of the House of

Representatives passed a resolution calling for a review of the current project. A movement had long been underway which sought to end projects undertaken as aids to navigation alone. The reigning view was toward combining power and navigation interests. It had already happened on the Tennessee and many felt that the Cumberland was long overdue (Annual Report of the Chief of Engineers 1924: 1169-1170; Johnson 1978: 160-161).

Nineteen twenty-four was a momentous year for the Cumberland River improvement projects. The last lock currently under construction, Lock 8 on the Upper Cumberland, would be put into operation and the decision would be made to abandon plans for any further construction outlined in the current project. Locks Nos. 9-17 would never be constructed.

Although Lock E had been placed in operation almost two years earlier work still remained to bring it to completion. During the work season of 1924-1925 10,000 cubic yards of gravel backfill was placed behind the dam and riprapped with 1,050 cubic yards of stone to hold it in place. Scour continued to be a problem and an additional 2,789 cubic yards, solid measurement, of stone was placed along the toe of the dam (Annual Report of the Chief of Engineers 1925: 1109).

Lock F, placed in operation the previous year, was about ninety-three per cent complete in July, 1924. In the year that followed the remainder of the cofferdam was removed, 930 cubic yards of derrick stone was placed along the toe of the dam, and 303 cubic yards of concrete was placed in the wing wall of the lower guide wall. Both concrete paving and riprap paving were installed. Backfill was placed, 1,056 cubic yards behind the lock wall and 12,000 cubic yards behind the dam. Other work included excavation of the lower approach, grading and surfacing roads, and grading and surfacing 1,00 square yards of steamboat landing. At the close of the year the reservation was cleaned up and all unneeded equipment sent to other sites (Annual Report of the Chief of Engineers 1925: 1110).

Figure 22: The buildings at Lock C. This includes lockmaster's house and support structures as they appeared in 1939.

Little remained to be done to finish the project on the Lower Cumberland. One lock house each at Locks B, C and D was yet to be built and minor improvements were needed at these locks and Lock F. It was expected that the project would be completed by June 30, 1926. Improvements at

Lock A continued. A water supply and fire protection system was virtually finished by the close of the year. A 25,000-gallon wooden tank was erected on the bluff 230 feet above the pool and connected by a 4-inch galvanized iron pipe to a gasoline-operated triplex 4-inch pump at the river. Major repair were necessary at Dam D. The dam was backfilled with gravel and 100 linear feet of sheet steel piling driven through the gravel against the upper side of the dam to replace the wooden breast sheathing, which had been removed by the action of the river (Annual Report of the Chief of Engineers 1925: 1111, 1119).

At Lock No. 8 the steel lock gates were erected, the upper guard wall completed and the banks graded and paved; 13,494 square yards of riprap having been placed in all. The dam was begun and completed in the space of a few months and, when finished, contained 527,000 feet, board measure, of timber and 8,284 cubic yards of stone filling. Over 23,000 cubic yards of backfilling was placed behind the lock and abutment walls and 2,550 cubic yards of derrick stone were placed along the toe of the dam and abutment pavement. Excavation of the upper and lower lock approaches was completed and 800 linear feet of cofferdam removed. Two lockkeepers houses were completed as well.

Lock No. 8 was placed in operation on September 15, 1924. Although in operation, backfilling, placement of derrick stone below the dam and some earth excavation remained to be done. It was expected to complete Lock and Dam No. 8 by December 30, 1925 (Annual Report of the Chief of Engineers 1925: 1119).

Although the Cumberland River improvement project was virtually complete minor construction projects remained. Bids for constructing lock houses at Locks B, C, and D had been received but the contract had not yet been approved. It was fully expected that the residences would be complete by the end of December 1926. Lock 8 was considered ninety-nine per cent complete, backfilling the dam, placing derrick stone below the dam and dredging the bank were that remained to be done. It was expected that these tasks would be completed by the beginning of the new year, 1927 (Annual Report of the Chief of Engineers 1926: 1089-99, 1104-1105).

In the meantime, a decision had been reached concerning the direction improvements made to the Cumberland would take in the future. “Under date of May 13, 1926, the Chief of Engineers recommended that the project be modified so as to provide for elimination of the proposed Locks and Dams Nos. 9 to 17, inclusive, and the substitution of a combined power and navigation system to consist of three dams at such locations and of such heights as to canalize the entire stretch in question to a depth of 6 feet at low water from the head of the 6-foot low-water pool of Dam No. 8 to Dam No. 21 with appropriate locks . . .” (Annual Report of the Chief of Engineers 1926: 1103).

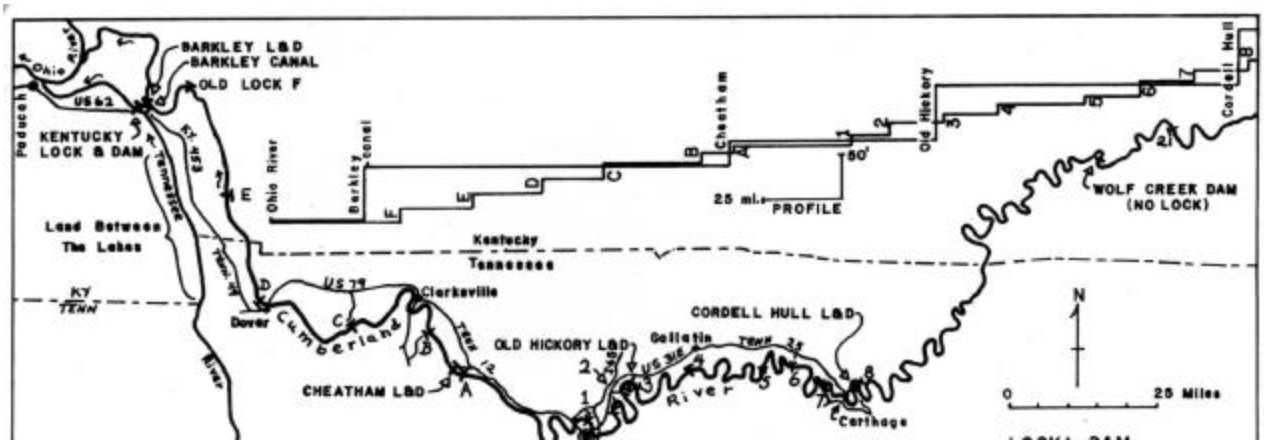


Figure 23: Map showing the location of the locks and dams on the Cumberland River.

Finally, in the Annual Report released June 30, 1928, the District Engineer was able to report in reference to Lower Cumberland: "All locks and dams under this project have been completed," and in reference to the Upper Cumberland: "Under the existing project Locks and Dams Nos. 1-8, inclusive, and No. 21 have been completed." The Cumberland River Improvement project begun forty years earlier was finally over. The total cost of these fifteen locks and dams on the Cumberland was $8,151,472.26. As originally conceived the improvement project was never to be completed. A new era was dawning on the Cumberland, one that would change the character of the river forever (Annual Report of the Chief of Engineers 1928: 1169, 1174).

A New Era

By the time the improvements to the Cumberland described above were completed the river, and the world, was a different place than it had been in 1888 when construction began. The locks and dams had been designed to aid steamboat navigation, the principal type of commercial craft then on the river, but steamboats had, for the most part, already left the river by the time the locks and dams were all put into operation.

The golden age of steamboats had been in the mid-nineteenth century. After the Civil War tonnage carried by steamboats on the Cumberland rebounded briefly, but the respite was short. By 1890 steamboats were already beginning their decline as they received increasing pressure from railroads. Rivermen began to look for new ways to compete with the railroads in the years to come, a way to haul large volumes of slow-moving freight. Although few of the old hands on the river seemed to realize it, the answer was already on the river – barges. Covered barges, decked barges, cargo barges, square bow barges, model bow barges, barges of all descriptions could already be found on the river; barges which could be lashed together and pushed by one steamboat, making it capable of transporting cargo in unheard of quantities (Douglas 1961:246).

By 1900 the practicality of towboats was no longer being argued. In fact, the construction of the locks and dams on the lower river aided their development. Large quantities of raw materials were needed in the construction – sand, gravel, rock and heavy timbers. Most of the lock sites had no near rail access or road access. As it had for one hundred years, the river served as the major artery of transportation. A large, localized towboat business grew up in response to this need, much of the raw material coming from the banks of the river itself. Manufactured materials, such as cement and iron, were also delivered to the construction sites on barges (Johnson 1961: 264-265).

These first towboats were powered by steam and pushed rather clumsy wooden barges, but new technology and improved marine design brought rapid changes. By 1920 the gasoline-powered towboat had arrived, "long and sleek, with a pair of tow knees draped over her square bow and an exhaust like a firecracker" (Douglas 1961: 259). These boats, although possessing neither the beauty nor dignity of a steamboat, had a latent power never even dreamed of by the captains of old. They were the forerunners of the diesel towboat, which would revolutionize water-borne commerce. The first towboat with reversible, diesel twin-engines on the Cumberland was the

Harvey, a prototype built by Nashville Bridge Company for T. L. Herbert and Son (Douglas 1961:259-261; Johnson 1988: 8.15).

By the 1920s, as typical commercial common carrier freight continued to decline, private businesses were beginning to recognize the advantages of owning their own towboats, or of chartering them for their exclusive use. These towboats carried bulky freight that was not bothered by exposure to weather, materials such as sand, gravel, rock, crossties, staves and heavy timber. Much of this traffic was dubbed "localized" and its short-run nature became a weapon yielded by those who fought any further government expenditure to improve the Cumberland (Douglas 1961: 265).

Figure 24: Wooden scale models of the A-frames wickets.

By the end of the first quarter of the 20th century it had become apparent that the locks and dams, so recently completed, were already out of date. The improvements had created a six-foot pool depth, but the completion of Lock and Dam No. 52 on the Ohio in 1928 had created a nine-foot depth on the Ohio. Lock and Dam No. 52 was the last in a canalization project that had commenced in 1879 with the construction of the Davis Island Dam just below Pittsburgh. Originally planned to provide a six-foot navigable depth, in 1910 the project was modified to provide a nine-foot depth for the entire river. In practical terms this meant that for boats, entering the Cumberland from the Ohio was like a train moving from a standard to a narrow gauge track. By about 1930 petroleum companies were experiencing difficulties. Their Ohio River barges could be loaded only to half capacity if they wished to come up the Cumberland. Time and time again the powerful diesel towboats pushing strings of steel barges experienced problems, not only from the shallow channel depth but from the small size of the lock chambers. In time barges as large as 50 by 290 feet were passing through the locks, with a bare one foot of clearance on each side and the bow and stern projecting over the miter sill (Besson 1932; Johnson 1978: 156, 159; Ylvisaker 1930).

Between 1930 and 1935 interest in rivers as arteries of transportation was revived. About 1930 Congress appropriated funds to carry out many vital river improvements and in 1933 the installation of movable A-Frame wickets on the crests of Dams 1 and A through F was authorized under the National Industrial Recovery Act. The Public Works Administration allotted $868,000 to install the wickets and concrete caps atop the old timber crib dams. It would be the first large-scale application of A-Frames in the US and would prove to be quite successful (Johnson 1978: 193-194).

Once installed the steel A-Frames were each about a foot wide and were high enough to add another three feet to the depth of the pool behind the dam. During high water the wickets were collapsed sideways, to lie flat on top of the dam, permitting the unimpeded passage of floodwater, debris and river traffic. When the water subsided, the wickets were raised by tossing a grappling hook into the water, catching the wickets and raising them one by one. Although installed as a flood control measure the A-frames had an added, very real, benefit. When fully raised a navigable channel, with a depth of nine feet, was secured in times of low water. The A-Frame wickets were installed by removing the top portion of the timber crib dam and replacing it with a reinforced concrete cap. Piling was driven into foundation rock throughout the old dam and lumber sheeting was replaced with sheet steel piling driven into the rock along the upstream face of the dam (Johnson 1978: 193-194).

Figure 25: Lockmen raising the A-frame wickets in 1934.

The nine-foot channel depth achieved by the installation of the A-Frame wickets did much to facilitate the growth of commerce on the Cumberland that began about 1935 and mushroomed after World War II. Big tows came with increasing frequency up to Nashville, even though the small size of the locks required that the tow be split into two or three pieces. As commerce on the Cumberland began to revive, with the development of the modern diesel towboat and welded steel barge, the era of multi-purpose dams on the river began (Douglas 1961: 294-298; Johnson1978: 193; Johnson 1988: 8.3, 8.8).

The Development of Multi-Purpose Dams

The idea of multi-purpose dams was nothing new. In 1841 a pamphlet was printed entitled: "Improvements for the Creation of Water Power by Means of a Dam and Lock in the Cumberland River, Three Miles Above Nashville" which proposed the erection of a dam and lock across the river and a canal through Lewis' Bottom for the purpose of creating water power for manufacturing. The project had the support of the mayor of Nashville and several prominent citizens but no action resulted. The idea of multi-purpose dams was revived around the end of the 19th century as engineers and other became intrigued with the idea of generating electric power with falling water. President Theodore Roosevelt was enthusiastic in his support of such projects, declaring that water resources should be made to serve the people in as many different ways as possible. In 1905 construction began on the Hales Bar Dam, built below the Suck near Chattanooga, on the Tennessee River. This was a pioneering project in every sense of the word. The engineering techniques were unknown and untried. Hales Bar was not an unqualified

success but it paved the way for the projects that followed. One such project was the magnificent Wilson Dam, also on the Tennessee, begun in 1918 and completed in 1926 (Bass, et. al. 1841; Johnson 1978: 164-174; Johnson 1988: 8.10).

A survey conducted between 1923 and 1926 resulted in a favorable recommendation on the feasibility of constructing multi-purpose dams on the Upper Cumberland. Floods in 1926 and 1927 brought a great cry for flood control programs in the Cumberland Valley and sites for six reservoirs were investigated. The first multi-purpose dam built on the Cumberland would be Wolf Creek Dam in 1952, which created Lake Cumberland. Over the next 20 years four more multi-purpose dams were constructed on the Cumberland: Old Hickory in 1956, Cheatham in 1959, Barkley in 1966 and Cordell Hull in 1973. Dams were also built on the tributaries of the Cumberland. Dale Hollow Dam was built on the Obey and Percy Priest on the Stones River (Johnson 1978 216-221; The American Canal Guide, July 1979: 17-19; Toplovich in Van West 1998: 228).

Conclusion

Little remains of the fifteen original locks and dams it took the Army Engineers so long to build. Portions of the some of the locks may still be seen, such as the land walls, steps, gauges, the lock keepers' houses and support structures, which still remain today. Parts of Lock F are visible but Lock E has been inundated by Barkley Dam, as has Lock D. Portions of the land walls and other features may still be seen at Locks A, B, C and 1 and 2. The dams and a portion of the lock at Locks A and No.1 were demolished in 1958 because they created a navigational hazard on Cheatham Lake. Locks 3 and 4 are intact, gates and all, but have both been covered by Old Hickory Lake, created by Old Hickory Dam. Portions of Locks Nos. 5, 6 and 7 may still be seen. Lock No. 8 is intact, but submerged under thirty feet of water backed up from Cordell Hull Dam. Lock No. 21, too, is intact but is beneath Lake Cumberland (Nashville District Corps of Engineers: 1958; The American Canal Guide, July 1979: 17-19).

For forty years inadequate appropriations, public apathy and opposition from landowners plagued the canalization project. In many respects it is astonishing that the improvements were made at all. The Cumberland River Improvement Project struggled to completion as river traffic on the Cumberland fell to an all-time low. But as commerce revived the locks were there to facilitate that growth. As small as the locks were they would prove to be invaluable in the intervening period between steam and modern diesel towboats. The period of usefulness of Locks and Dams A-F and Nos. 1-8 and 21 may have been limited but they represent the first efforts of man to control the Cumberland, to make the willful river bend to the needs of man. Today multi-purpose dams control the river from Burnside to Smithland in a way never envisioned when the canalization of the Cumberland was undertaken in 1888 but those first locks and dams also deserve recognition (Douglas 1961: 260-263).